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I. ON THE TEMPERATURE OF THE SUN.*

By Professor S. P. LANGLEY.

IT is known to all that there is a problem of the highest interest in solar physics at present waiting solution. I mean that of the temperature of the sun; and, so far as the whole radiant energy is inferable from the rate of emission of heat, the problem is one the theoretical solution of which is evidently dependent on our knowledge of the laws of cooling.

Every operation of Nature, whether in the organic or inorganic kingdom, is accompanied by the emission or absorption of heat, and, considering that—whether the subject of observation be the germination of a seed, the heat of a stove, or the outflow from the sun upon the planetary system—we want to know the rate of the deperdition of energy, one might certainly suppose that no physical law would have been better ascertained; but we are here, however (at least in regard to high temperatures), in a state of nearly complete ignorance, and know almost literally nothing about what so intimately concerns us. This is a reproach to modern physics, which has probably made no real advance here since Newton. To justify this language I remark that, in the case of the solar temperature, the *amount* of heat the sun sends us is scarcely in question, as we are all substantially agreed on the way to measure this and on the results of measurement. The latest of these give, it is true, larger values than those of Pouillet, which were about 1·75 calories per centimetre per minute, instead of 2·50; but these considerable variations are so trifling compared with those in the deductions made from them, that we may still say there is substantial agreement as to data. From like data, then, Sir John Herschel concludes that the temperature of the solar surface is over 5,000,000° C.; Mr. Ericsson, whose labours on this point deserve wider recognition, is confident that the temperature is not materially different from 4,000,000° F.; Father Secchi, in his latest research, makes it 133,000° C.; Sir Wm. Thomson and others estimate 30,000° to 60,000° C.

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* A Paper read before the American Academy of Arts and Sciences, October, 1878. Communicated by the author.

These extremely gross discrepancies having drawn general attention, many distinguished French physicists have lately re-investigated the subject, and, using Dulong's and Petit's formula, have after most elaborate research arrived at the nearly unanimous conclusion that the temperature of the solar surface is altogether lower than any of these,—is in any case not more than 2000° to 2500° C., but is more probably below than above the temperatures which are reached in our furnaces, and in fact is probably less than that of melting platinum.

It is here to be borne in mind that we really know nothing about the absolute emissive capacity of the solar surface, and that to simplify the problem, when we speak of the sun's being at a lower temperature than that of a certain lamp-black surface or hot platinum or steel, it is assumed, for the purpose of comparison, by myself as well as by the above-named investigators, that both the solar and terrestrial sources of heat have the same emissive capacity. The temperature thus defined has been called the "effective" temperature.

M. Violle, one of the most distinguished students of the subject, whose experiments bear evidence of intelligent care, found by observations at Grenoble, in March, 1874, that, with an emissive power thus defined, the temperature of the solar surface was 1230° C.* In a subsequent memoir he finds for the same the rather higher value of 1354° C.† After allowing for absorption in our atmosphere, it remains true that the temperature is then much below that of melting platinum, and this seems to be confirmed by his later results, which give about 1550 C. as the highest "effective" temperature.

All these and other observations involve the use of the empirical formula, well known as that of Dulong and Petit, which has replaced the earlier and simpler one of Newton.

Now, whatever be the apparent presumption of opposing my opinion to that of so many conscientious and recent investigators, I feel there is something yet to be said; and the present paper is an account of experiments of a special character, undertaken at the expense of the Rumford fund, not with the hope of at once solving so arduous a problem, but with the wish, in this confusion of opinion, to contribute one or two incontrovertible facts as material towards the construction of future theory. I hope to show convincingly that the sun's "effective" temperature is, at any rate, far above that of any ordinarily attained in the arts (very much above that of melting platinum for instance), and incidentally that the law of Dulong and Petit is untrustworthy precisely where we need to apply it.

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* Comptes Rendus, vol. lxxxviii., p. 1425.

† *Id.*, p. 1816.

If we have no formula by which to infer the temperature of the sun, there remains the comparison of its radiation with that of a terrestrial source of high *known* temperature. Thus the late Father Secchi has measured the radiation from the electric arc, and M. Violle that from a Siemens-Martin's furnace; but, by comparing these only with others made at other times on the sun, discrepant results appear also. Were we, however, to compare the sun *directly* with a terrestrial source of high temperature, and bringing them face to face find one giving more heat than the other, there could (with equal emissive powers) be no question but that the body radiating more heat was also the higher in temperature. Strange to say, this simple test has never, that I know, been applied to this problem* until in the experiments I am about to describe.

We have in the arts one process which gives what we want ready to hand in the production of a vertically disposed surface of several square feet of a liquid metal, hotter than melted platinum itself. I refer to the Bessemer process now in use in several places in this country, among others at the Edgar Thompson steel-works, about twelve miles from Pittsburg. I have received every possible assistance from the managers of this great establishment, and owe my acknowledgments here for their kindness.

As the Bessemer process may be as vaguely known to some as it was till lately to me, I will first briefly describe so much of it as concerns the present purpose.

An enormous egg-shaped vessel called the "Converter," capable of holding 30,000 to 40,000 pounds of melted metal, is swung on trunnions so that it can be raised by an engine to a vertical position, or lowered so as to pour its contents into a cauldron. First, the empty "converter" is inclined, and into its mouth is poured about 15,000 pounds of fluid pig-iron, whose temperature as it flows in from an adjacent furnace, where it has previously been melted, is about 1400° C. Then the "converter" is lifted to an erect position, and an air-blast from a powerful blowing-engine is forced up through its liquid contents. In the 15,000 pounds of impure iron there are ordinarily found about 230 pounds of silicon and 540 of carbon; and as each pound of carbon gives 8,000 calories, and each pound of silicon 12,000 to 14,000, in connection with the air-blast's unlimited supply of oxygen, the temperature of the already molten metal rapidly rises under this enormous inflow of several million calories of heat. After the blast has continued eighteen to twenty minutes, the temperature of the contents is from 1800° to 2000° C., or higher than that of melted platinum, taking the lowest estimate; and now the "converter" is again lowered, and about 1500 pounds more of melted iron added. The temperature here, perhaps, falls slightly, but its effect may be judged by any one who sees this second lot of iron poured in. Melted iron by itself, every one knows, seems dazzlingly bright; but as this streams into the open mouth, the interior is so much brighter still, that the stream is deep-brown by comparison, presenting a contrast like that of dark coffee poured into a white cup. The contents are no longer iron, but liquid steel ready for pouring into the cauldron; and, looking from in front into the inclined vessel, we see the almost blindingly bright interior dripping with the drainage of the metal running down its sides, so that the circular mouth, which is twenty-four inches in diameter, presents the effect of a disk of molten metal of that size, were it possible to maintain such a disk in a vertical position. In addition, we have the actual stream of falling metal which continues nearly a minute, and presents an area of some square feet. The shower of scintillations from this liquid cataract of what seems at first "sun-like" brilliancy, and the immense area whence such intense heat and light are for a brief time radiated, make the spectacle a most striking one.

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* Experiments with the lime and electric lights made for other purposes are not here in question.

Platinum dipped in the steel as it pours from the lip melts away; and not to rely on this evidence, which might be alleged to be due to an alloying rather than a true melting, I procured some platinum wire which Mr. Preusser, the chemist of the works, stretched, at my request, across the open mouth of the "converter" when in an erect position. The platinum, here several yards above the metal, was melted by the blast which came from it.

Heat Comparisons.

After many visits to the works, much trouble and repeated failures due to the difficulties of working in such novel circumstances, I secured a series of trustworthy measures, in May last, both of heat and light. I describe my apparatus here in principle, not in detail; and I omit many preliminary experiments, as well as some minute corrections applied for small instrumental errors, giving my results in general terms. One difficulty attending a simultaneous comparison was to obtain a station looking into the "converter" at the time it was inclined and pouring, and yet necessarily outside the building in the sunlight. To do this, I stood in a window (whence the sash had been removed) of the west wall, sixty-one feet from the "converter" mouth. A platform was erected here for my apparatus, part of which was clamped to the wall itself; but though this was the best point of observation, the noise, the shower of sparks driven over the instruments from within by the blast at each "pour," and the rain of wet soot without which fell thick at times on apparatus and observer from the combined steam and smoke of adjacent chimneys, made the task of observation another thing from what it is in the quiet of a physical cabinet.

From this window-station, a *porte-lumiere* reflected the sun's rays, so that traced through the dusty air the beam was seen to enter the "converter" mouth, or fall on the stream which ran from it. In the path of this beam was a cylinder, containing within a double enclosure an Elliott thermopile of forty small elements, similar to that I had used for some years on the sun, and surrounded by all the precautions against air-currents and extraneous influences taught me by experience. The pile exposed both faces at once, one to the furnace, the other to the reflected sunbeam; and a Thompson reflecting galvanometer read by an assistant, and placed at a considerable distance from any moving iron, gave prompt evidence as to which face was hotter.

The angular area, subtended at the pile by the fluid metal, was always many times that subtended by the sun's disk, and there was no lens or medium of any kind (except air) between the "converter" mouth and the pile. Supposing, then, the metal to have only presented a disk equal in angular diameter to that of the sun, if the needle remained stationary, it is plain that each was sending an equal amount of heat, and that any square foot of the solar surface was radiating at least as much heat as a square foot of the metal; for it is obvious that the distances of the two sources have nothing to do with this effect under the given conditions.

The metal area, however, being many times that of the sun, the latter still over-balanced the metal; showing that the sun was actually very much the hotter. Accordingly, there was interposed between the *porte-lumière* and the pile a telescope which diffused the sun-light over an image of any given diameter. As the solar light entered only through a diaphragm of known dimensions, it was easy to say how much the sun's heat was weakened to balance that from the metal. It must be borne in mind, however, that there was no account taken of the loss of solar heat by reflection and absorption in the lenses, by reflection from the mirror, and more than all by the frequent clouds of smoke and steam, while the furnace heat suffered no diminution whatever. Further, every other condition of the experiment was designedly such as to weigh in favour of the furnace and against the sun's heat. The value found for the latter, then, is a minimum value. I should, perhaps, have remarked that experiments had shown that the trifling heat from objects near the melted metal might be neglected. That from the atmosphere about the sun was also insignificant. Except, then, for the diminution of solar heat by absorption, reflection, and so on, our method is equivalent to bringing a specimen piece from the sun's surface (if I may so express myself) face to face with one from the furnace, placing our thermopile mid-way between them, and determining how much we have to diminish the size of the former to make its heat-radiation no more than equal the latter's.

The result of these experiments was that the minimum value we can assign to the solar radiation is eighty-seven times that from an equal area of the pouring metal. This, it will be remembered, is not an actual but a minimum value. The true value may be indefinitely greater.

Photometric Comparisons.

Of the complex radiations from any source of high temperature, a part is interpreted by the pile as heat, a part by the eye as light; but as the temperature is raised, it is now well known that the waves of shorter length increase in amplitude much faster than the longer ones. If the temperature of the sun, then, be much greater than that of the furnace, we shall have a quite independent proof of the fact in a photometric comparison, which, we can safely pronounce *a priori*, will then give a very much greater ratio of sunlight to furnace-light than that of sun-heat to furnace-heat. To make this comparison, a photometer box, about 8 inches in square section and 66 inches in length, is placed so that its central axis lies as before in the path of the reflected beam from the mirror to the furnace. Two similar telescopes of 1·66 inch aperture and 20·01 inches focus, having their objectives outside the extremities of the box and their optical axes in the path of the beam, project, by their eye-pieces, images of the sun and of the pouring metal on the two sides of a Bunsen disk, whose normal position is in the centre of the box. Both images are viewed simultaneously by mirrors attached to the disk, which is movable along a graduated scale. (I here omit certain small corrections applied in practice, and describe the use of the instrument in brief terms.) We do not now need to consider the relative angular areas of the sun and furnace, for so long as both are of appreciable size the images of both falling on the screen, when nearly midway between the two telescopes, will be sensibly proportioned in brightness to the absolute intensities of the sun-light and furnace-light. We do, in fact, however, at the outset find the sun-light so immensely brighter that no direct comparison is possible. We then diminish the aperture of the solar telescope (which we will call A), till it has a small known ratio to that of the furnace telescope (which we will call B). In practice B was always left with the full aperture of 1·66 inch diameter, while that of A was 0·192. Were the original sources of equal intensity, the sun-light would have been reduced to $\left(\frac{0{\cdot}192}{1{\cdot}660}\right)^2 = 0{\cdot}013+$ or a little over one one-hundredth of the other. But it was surprising to see that the image from A was even now incomparably stronger than that formed either by the flame from the blast at its brightest, or by the pouring metal. Under these circumstances, the Bunsen disk was moved from its central position toward B, thus approaching the apex of one light cone and withdrawing from the other, so as to diminish the sun-light still further in an exactly determinable ratio. The lowest value obtained in a series of accordant measures gave intensity of sun-light over (5300) five thousand and three hundred times that from the metal; and this value is, I think, considerably below the truth.

It results from these experiments: (1) That direct observation disproves the statement that the sun's effective temperature does not exceed 1500° C. It is demonstrably over 1800° C., and may for anything here shown to the contrary be indefinitely greater.

(2) The solar heat-radiation, so far from being comparable to furnace heat, is at a minimum something like 100 times that from melted platinum, area for area, and probably much greater.

(3) The solar-light radiation (which offers a more trustworthy indication of the total difference between the sum of all degrees of radiant energy than the heat) is over 5300 times that from a temperature above that of melted platinum.

(4) Since all the above results are simple statements of the facts of experiment, and are independent of formulæ, we conclude that the formula of Dulong and Petit (which from well-conducted experiments, like those of M. Violle, deduces conclusions which trial disproves) must be itself wrong. Further, since this formula contains no term depending on the wave-length, it takes no account of the difference here proved to exist between the relative quantities of heat and light radiation from sources of high temperature, and is thus found especially untrustworthy at those temperatures at which it has been most frequently applied.

I do not yet venture an opinion of my own on the real temperature of the sun, further than that I think it much higher than has been of late believed.

The preceding observations and inferences all seem to point to the use of the highest attainable terrestrial temperatures (*e.g.*, that of the electric light) in comparisons (and the consequent least dependance on formulæ) as the safest line for future investigation.

II. SCIENTIFIC MATERIALISM AND ULTIMATE CONCEPTIONS.*

UNDER the above title Mr. Sidney Billing has issued a work which even those who dissent most widely from the author's views will find, we think, worthy of a careful examination. Its main features are a vigorous critique of scientific materialism as expressed more or less overtly in many works and speeches of the present day, and especially in the famous "Belfast Address" and "Birmingham Oration" of Prof. Tyndall; a protest against the license of so-called "scientific imagination" and against the dogmatic intolerance—shall we say of official science? Lastly, the author calls in question the received theory of heat as a molecular and ethereal vibration, and suggests that it should be regarded as a substantive entity, "the primordial unity out of which matter arose," the principle of all terrestrial phenomena, but itself a product of intelligence. These three questions are not discussed separately and seriatim, but are interwoven together, and accompanied by utterances and reflections on a great variety of subjects, which, if not always strictly relevant to the main issues, are often highly original and suggestive. As an instance we extract the following note:—"The red-skin hunter hoped to be translated to a region abounding in game. The Maori believed that life after death is a series of skirmishes in which the blessed are always victorious. The Teuton of old nourished the same hope. Civilisation cramps such aspirations. Would the cotton-weaver be content to labour for ever in cotton-mills, even though they were miles upon miles in length?"

Mr. Billing brings to his task an amount of erudition which we must pronounce wonderful. He has read and has at command not merely scientific and quasi-scientific, but non-scientific and even anti-scientific, works. Carlyle, Fichte, Bruno, Spinoza, Lucretius, Hume, Cousin, Radcliffe, and Noah Porter are as familiar to him as Humboldt, Liebig, Kekulé, Helmholtz, Darwin, Du Bois-Reymond, or the "Bridgwater Treatises." We find, however, no sign that he is an experimentalist or observer in any branch of science. For a further understanding of his position we may remark that he is an Evolutionist—though somewhat encumbered with teleology—and an admirer of Darwin. Though a stout opponent of what is called "materialism," he is far from identifying himself with any of the creeds. Hence every man's hand will be against him. He has blasphemed South Kensington in the person of some of its chiefs, and has failed to conciliate Exeter Hall and the tea-tables.

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* Scientific Materialism and Ultimate Conceptions, by SIDNEY BILLING. London: Bickers and Son.

As far as regards his denial of the dogma that in matter we have "the promise and potency of every form and quality of life," we are with him heart and soul. Nor can we dissent from him when he enters his indignant protest against the part now played in science by imagination, in the absence of demonstration. Philosophers have in former days denounced the credulity of religionists. Alas! it is to be feared that in our time the authorised expounders of science make larger demands on the unreasoning faith of their hearers than did ever the apostles of a new religion. When we overlook the field of human knowledge, and consider how much is assumed and how little is really established, we are seized with a deep sadness. Nor is this scientific faith genial and tolerant. It is too true, as the author quotes from Prof. Kekulé, that all "who sin against these dogmas are persecuted as heretics." Said Professor Tyndall in his much discussed Belfast Address:—"There is in the true man of science a wish stronger than the wish to have his beliefs upheld, namely, the wish to have them true, which causes him to reject the most plausible support if he has reason to suspect that it is vitiated by error." These are brave words; but though the accepted theories of heat and of light are admittedly not free from difficulties, how many physicists could be found willing to submit such theories to a full re-consideration, and to weigh the arguments in favour of the hypothesis which our author seeks to revive? Nay, what is the reception met with by an experimental fact which seems to point in some heterodox direction?

Mr. Billing, who takes for his motto the sober watchword of Du Bois-Reymond, "*Ignoramus—Ignorabimus*," compares with the thoughts which it embodies certain other phases of German speculation as brought popularly forward in the "Munich Addresses" of Nägeli, Haeckel, and Virchow. The first of these worthies, who for our tastes is far too sanguine in his expectations of what scientific certainties we may yet attain, proposes as a counter-cry "We know, and shall know, if we be content with human insight,"—a saving clause capable of exceedingly wide application. As to Prof. Virchow, we distrust him. His ostensible watchword, as here quoted, is "That which honours me is a knowledge of my own ignorance;" his esoteric motto is said to be "Restringamur," *i.e.*, academic freedom, and, probably, the liberty of the author as well as of the professor. The charge brought against him, that he is intriguing to eject all Evolutionists from their chairs in the German universities, has not been formally demonstrated, but it is strongly countenanced by the following language which he has undoubtedly used:—"I only hope that the theory of Descent may not bring all those horrors in our country which similar theories (!) have actually brought to our neighbours. Anyhow this theory, if carried through to its consequences, has an extremely dangerous side, and that the Socialists have a certain notion of it already you will doubtless have remarked." We will not dictate to Mr. Billing what estimate to form of the man who makes this artful and disingenuous attempt to excite the *odium politicum* against a theory which he dislikes. In spite of his well-known abilities Prof. Virchow might feel somewhat puzzled if bound to name the "similar theories" which have given rise to "horrors" in France. If he really believes what he here professes he can scarcely have taken the trouble to examine what the tendencies of Evolutionism truly are, and his "knowledge of his ignorance," before it can throw any great honour upon him, will require to be supplemented. Were this the legitimate sphere for such a discussion it would be easy to show that the doctrine of Descent points in a direction the very opposite, and is flatly antagonistic to not a few of the leading principles of "social democrats" and "advanced political thinkers." This task, however, has been ably executed by Prof. Oscar Schmidt, to whose memoir we refer the reader.

The author's criticism of the Belfast Address and the Birmingham Oration, able as it must in many respects be pronounced, comes too late. We cannot help, however, noticing that the story of the "merchant convulsed into action by a telegram," quoted by Prof. Tyndall from Lange, points in reality to one of the most powerful arguments against the materialistic (somatic) theory of life A man is, we will suppose, at dinner with a brisk appetite. Suddenly he receives—whether by letter, telegram, or verbal message it matters not—some alarming message. A dear friend may have been taken dangerously ill; or a litigious idiot, of whose very existence he was ignorant, may have brought against him an action for libel. What is the result? His appetite is gone, and all the ordinary symptoms of indigestion come on. Yet for all this there is no physical cause. No material substance has been introduced into or withdrawn from his system. No "force," using the word in its ordinary sense, acts upon him in a different way from what it did previously. A purely immaterial something, a piece of intelligence, has acted upon him like a dose of poison. That such psychic poisons—if we may be allowed the expression—can even prove mortal the annals of medical science fully show.

These considerations bring us to one of the points on which we have not the pleasure of agreeing with Mr. Billing; we refer to his disposition to draw what to us appears far too absolute a boundary-line between man and the lower animals. It is superabundantly proved, as far as testimony can prove anything, that in brutes, also, ill health —chronic or acute—may be occasioned by purely immaterial causes, such as fear or distress.

The author's assumption that the intelligence of the lower animals is "not that of an individual, but of the whole species," is flatly contradictory to the experience of all who have taken trouble to observe closely and fairly. Between different individuals of the same species, and even of the same race, there occur the most manifest differences in mental power. One dog hits upon devices and stratagems to secure his ends which never strike another. One spider will ballast its web in stormy weather with, *e.g.*, a chip of wood, whilst other spiders of the same species, with the same facilities and under identical circumstances, do no such thing. Mr. Billing, we are sorry to perceive, goes the length of ascribing cases of animal intelligence to an error on the part of the observers. In other words, he refuses to admit facts contrary to his prepossessions. The assumption of an "innate potence" distinct from reason, and yet fulfilling the tasks of reason, is in truth a desperate attempt to uphold a decaying error.

The extent to which our author's science is diluted with "Bridgewater" is also to be regretted. We demur altogether to the fundamental assumption of teleologists that God's purposes are known to mankind; nor would it be hard to show, from indisputable facts, that if a maximum of earthly happiness for man had been His object, the world would assuredly have been constituted very differently from what it now is. Teleologists have been challenged to produce a new Bridgewater Treatise having for its theme the mosquito, the chigo, the *Lucilia hominivora*, the trichina: but they have prudently held back.

Bell is quoted as saying that "Canine teeth accompany a carnivorous appetite and boldness of disposition; boldness, fierceness, and cunning accompany retractile claws and sharp teeth." The truth is, however, that canine teeth are splendidly developed in the non-carnivorous gorilla, and are absent in the bold and aggressive buffalo; whilst in "boldness, fierceness, and cunning" the Canidæ and the Ursidæ, which have not retractile claws, do not fall short of the cats. Galen is incorrect if he says that the eaglet will attempt to fly when first freed from the egg-shell; it will sit helplessly waiting to be fed.

But space will certainly not permit us to enter upon the minute discussion of Mr. Billing's biological views, which to the present writer, as an old naturalist, seem the weakest part of an otherwise most valuable and interesting work.

The author not merely admits the high antiquity of the human race, but suggests the possibility of a high civilisation having been attained in times of which no written record has survived. "It is possible," he says, "Suleiman and the pre-Adamite kings, with their attendant genii, were traditional allegories of knowledge and power, and it may be the dwellers on the earth had compassed a knowledge thousands and thousands of years before the so-called historical era, and far exceeding that pourtrayed or which science conceives." All this *may* be, but we can at present merely guess, and not prove.

Two passages seem to us to convey a grave and needed warning. "A nation actuated alone by moral law, with conscience as a regulator or administrator, could not exist beside other nations impulsed by a lower ideal, because it would be the prey of instinctive rapacity."

The following reflection may be taken to heart by us all: —"So enslaved is the general mind by the authorities of the time that it is assumed to be treason to doubt the dicta of the leaders of the day, talk what or how they may—absurdities become logic; sensationalisms, eloquence; suicidal fanaticism, patriotism; and prose run mad, poetry; all because at some time in their era they have earned a name for *some themes logically reasoned, for some experiments successfully conducted, for some political conduct ably directed, and for some poems admirable and artistic.*"

We hope our readers will make personal acquaintance with a work which we would gladly have noticed in a style less hasty.

III. EXPLOSIONS FROM COMBUSTIBLE DUST.*

By Prof. L. W. Peck.

I WISH to demonstrate to you this evening, by a few simple experiments, the fact that all combustible material, when finely divided, forming a dust or powder, will, under proper conditions, burn with explosive rapidity.

If a large log of wood were ignited it might burn a week before being entirely consumed; split it up into cord-wood, and pile it up loosely, and it would burn in a couple of hours; again, split it into kindling-wood, pile loosely as before, and perhaps it would burn in less than an hour; cut it up into shavings and allow a strong wind to throw them into the air, or in any way keep the chips comparatively well separated from each other, and it might be entirely consumed in two or three minutes; or, finally, grind it up into a fine dust or powder, blow it in such a manner that every particle is surrounded by air, and it would burn in less than a second.

Perhaps you have noticed that shavings and fine kindlings will sometimes ignite so quickly in a stove that the covers will be slightly raised, the door forced open, or perhaps small flames will shoot out through the front damper. You have, in such a case, an explosion on a very small scale similar to that of the Washburn, Diamond, and Humboldt Mills of this city, on the night of May 2nd,—upon which occasion the rapid burning of hundreds of tons of flour, bran, &c., completely demolished the solid masonry walls (6 feet thick) of the mills, and threw sheets of iron from the roof of the Washburn so high into the air that they were carried 2 miles by the wind before striking the ground.

Let us now see why such explosions occur. Wood has in it a large amount of carbon, the material of which charcoal is composed, and the air is about one-fifth oxygen. Now, at the ordinary temperature, the carbon of the wood and the oxygen of the air do not combine; but when they are heated —as by friction, concentration of the sun's rays, chemical action as from a match, or in any other way—they combine to form carbonic acid gas. This chemical action produces a large additional amount of heat, which keeps up the action as long as there is any carbon and oxygen left to unite, and also makes the temperature of the gas which is formed very high.

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* Lecture delivered June 1, 1878, at Association Hall, Minneapolis, Minnesota, at the request of the millers of the city.

As the space occupied by the carbonic acid gas and that occupied by the oxygen which entered into the combination is the same at the same temperature, there would be no bursting if, after combination, the temperature were the same as before; but it is a fact, which you have all observed, that fuel in burning produces heat: it is also a fact that heat expands a gas, and it is this great amount of heat, taken up by the carbonic acid formed, that produces the immense pressure in all directions.

Let us return to our log of wood. There is exactly the same amount of heat and carbonic acid produced when complete combustion takes place in each of the cases of burning, the only difference being as to time. In the first case, the explosion or pushing aside of the surrounding air occupies a week, in the last only a second.

Snow-flakes fall gently upon your shoulders, and you are required to perform an insensible amount of work to resist the crushing effect of each flake; but suppose that all the snow that has fallen upon your head and shoulders for the last ten years was welded together in one solid mass of ice, weighing perhaps one hundred pounds, and that it should descend with the velocity of a snow-flake upon you, an immense effort would be required to prevent its crushing you, even if you were able to withstand the shock at all. The work of many days would be concentrated into an instant.

So it is with burning wood: four or five cords of wood and a large stove will give you a roaring fire all winter; the work done is manifested by the heat obtained, by the rushing of hot gases up the chimney, and of air from outside into the room through every crack. But if the wood were ground into a powder and scattered through all the house, and burned instantly, the cracks, doors, windows, and flues would not be sufficient to give vent to the hot gas, and the roof and sides of the house would be blown to pieces.

What is true of wood is also true of grain; also of vegetables, with their products when they contain carbon, with this exception—grain, either whole or ground, will not burn readily when in bulk. A fire could be built upon a binful of flour, and kept burning for half a day without igniting the flour; it would char upon the surface, but it lies in such a compact mass that the air does not get access to it readily; hence it does not burn.

I wish to show you now how combustible dust will burn when blown into the air by means of a pair of ordinary hand-bellows.

I have here two boards, about 12 by 18 inches, nailed together, forming a V (*see* Fig. 1). Just outside of the V an ordinary Bunsen gas-burner is placed, and within is a small handful of dust taken from a sash and blind factory. Upon blowing it smartly with the bellows a cloud is formed about 15 feet high,—extending, in fact, to the ceiling,—which ignites from the lamp and produces a flash, very quick and exceedingly *hot*, resembling very much a gunpowder flash. You will notice that a large amount of dust falls from all around the edge of the flame without burning; that is because it is not thick enough. Two things are necessary: first, that each grain of dust be surrounded with air, so that it can get the oxygen required *instantly*; and, secondly, that each grain shall be so near its neighbour that the flame will bridge over the space and pass the fire from particle to particle.

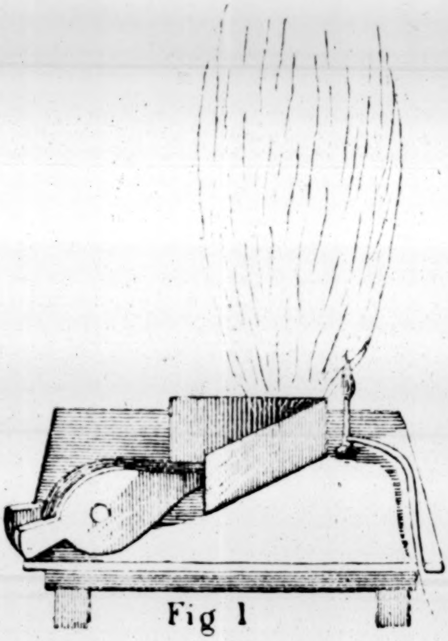
Fig 1

I think, after seeing the immense flame produced by such a small amount of fine saw- and sandpaper-dust, you will no longer wonder at the rapid spread of flames in furniture and similar factories. You know it is practically impossible to put out a fire after any headway is attained in these establishments; the draught produced will blow all the dust from walls and rafters into the air, and the building in an instant is a mass of flame. Perhaps many of you remember the fire in the East-Side Saw-Mills, a few years ago. Large masses of fine sawdust had probably collected upon the rafters, and the whole roof was perhaps filled with cobwebs loaded down with dust. A fire started from one of the torches used, and shot through the mills with lightning-like rapidity, and save for the fact that the ends and sides of the building were all open, there would have followed an explosion like that at the flour-mills. As it was, the men had very great difficulty in escaping with their lives, notwithstanding that a short run in any direction would have taken them out of the mill.

It is very evident that too great care cannot be taken to keep all such factories and mills as free from dust as possible.

I will now blow some ordinary starch into the air in the same way, and you notice the flame is more vivid than in the last experiment, and if you were in my position you would notice that the heat produced is much greater. Notice now that this powdered sugar burns in the same way.

You will see, from the experiments further on, that three-quarters of an ounce of starch will throw a box, weighing 6 lbs., easily 20 feet into the air, and that half an ounce burned in a box will throw up the cover 3 inches with a heavy man standing upon it.

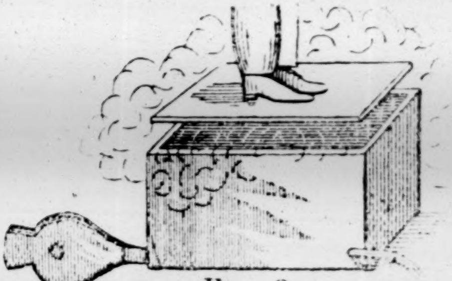

Fig. 2

With these facts, which I have demonstrated before you, no one need regard as a mystery the Barclay Street explosion in New York city, where a candy-manufactory, in which large amounts of starch and sugar might in many ways be thrown into the air by minor disturbances, took fire, and completely wrecked a building and destroyed many lives.

I will now burn in the same way some buckwheat, which, as you will observe, gives a very large blaze; now some corn-meal, which is too coarse to burn as well; now some rye-flour, which burns much better than the corn; now some oatmeal, the finer part of which only burns; and so I might continue with all sorts of finely-ground vegetable material.

Let us take up now the products of the manufacture of flour from wheat. There were between 300 and 400 tons of these materials, upon which I am now to experiment, in the Washburn Mill at the time of explosion, and there was a corresponding amount in the Diamond and Humboldt Mills, which, by their sudden burning, produced the second and third shocks heard directly following the explosion of the larger mill.

The wheat is first placed in a machine, where it is rattled violently and brushed. At the same time a strong draught of air passes through it, taking all the fine dust, straw, &c., and conveying it through a spout to a room known as the wheat-dust room, or perhaps more commonly it is blown directly out of the mill.

You see some of this material here; it looks like the wood-dust of the first experiment, and, as you see, burns with a quick and sudden flash when subjected to the same conditions.

Here, then, we have the first source of danger in a flour-mill. A thick cloud of this dust, when conveyed through a spout by air, will burn in an instant if it takes fire; and if there is any considerable amount of dust, as there would be if there were a dust-room, an explosion will follow which may become general if it stirs up a thick dust-cloud throughout the mill.

The wheat, after it has been cleaned in this way, goes to the crushers, which are plain or fluted iron or porcelain rollers, working like the rollers in a rolling-mill. The object of these rollers is, I believe, to break off the bran in as large pieces as possible, and to crush out or flatten the germ so that it can be separated with the bran from the rest of the meal.

The crushed wheat goes now to the stones, where so much heat is produced (average 135° F.) that a large amount of steam is formed from the moisture in the materials. This steam would condense in the meal, and interfere with bolting, &c., if it were not removed. To effect this another draught of air and another spout are employed, and, as might be expected, this current takes a large quantity of the very finest flour, called flour-dust, with it. To save this a room is provided near the end of the spout, called the flour-dust house. The spout conveying steam and dust enters this room on one side, and another spout opposite leaves it, passing to the open air. It is in this comparatively dead-air space that the dust settles, and can be collected from the floor. Here is some of this material, which, as you see, when blown into the air, produces a vivid flash, extending from the table to the wall.

The evidence taken before the coroner's jury shows very clearly that it was this material that started the great explosion of May 2nd. Just how the mill took fire will probably never be known, of course, but in all probability the stones either ran dry—that is, were without any meal between them—or some foreign substance, such as a nail, was in the feed, producing a train of sparks such as is produced by an emery wheel or a scissors-grinder's wheel. These sparks set fire to small wads of very hot dust, which, as soon as they were fanned into a blaze, communicated it to the spout and house full of dust. An eye-witness of the explosion first saw fire issuing from the corner of the mill where this flour-dust spout was situated, the end of the spout having probably been blown out. This fire was followed instantly by a quick flash, seen through all the windows of the floor upon which the flour-dust houses were situated, followed instantly by a flash in the second story, then the third, and, in rapid succession, fourth, fifth, and sixth stories; then followed the great report produced when the immense stone walls were thrown out in all four directions, and the roof and part of the interior of the mill shot into the air like a rocket.

It would seem that a blaze is necessary to ignite the mixture, for I have tried powerful electric sparks from a machine and from a battery of Leyden jars; also incandescent platinum wire in a galvanic circuit, and glowing charcoal, without producing any fire, however thick the dust might be. Perhaps, however, under more favourable conditions the dust would ignite directly from sparks, but it seems very improbable.

Let us continue now with the process through which the ground wheat is made to pass. From the stones it is conveyed to the bolting-reels, where the very finest is sifted out first, and we obtain a grade of flour; after the finer material is sifted out it goes to a coarser bolt, where the "middlings," as it is called, passes through, leaving the bran which comes out at the end of the reel. The middlings, as it comes from the bolts, has fine bran and dust in it, and, to purify it, it is subjected to an operation similar to that of cleaning the wheat,—that is, in the middlings purifiers it is subjected to a draught of air which takes away all the light bran and dust, leaving the heavier material (purified middlings), which goes again to the stones to be ground into flour,

Here is some of the dust from these "middlings-machines;" you observe it burns as the other materials burned, quickly, and with intense heat.

Here is some of the purified middlings; each grain is comparatively large and heavy, making it difficult to blow it well into the air, but, as the blaze produced by each particle is quite large, a flash is produced which does not differ materially from the others.

Here is some of the general dust of the mill,—that is, dust swept up from the floors, walls, beams, &c. You will see it acts in all respects like the other substances.

And, finally, here is some of the flour taken this afternoon from the flour-sack at home; it burns, you observe, if possible with even more energy than the other kinds of dust.

I have performed a few experiments, which I will now repeat, which will illustrate to you the immense power that these materials exert when burned in a confined space.

This box (Fig. 2) has a capacity of 2 cubic feet; the cover has a strip 3 inches deep nailed around it, so that it telescopes into the box: there is in this lower corner an opening for the nozzle of the bellows, in this an opening for the tube to the lamp. I place now a little flour in the corner, light the lamp, and my assistant places the cover upon the box and steps upon it. Take notice that upon blowing through the hole, and filling the box with a cloud of flour, the cover comes up suddenly, man and all, until the hot gas gets a vent, and a stream of fire shoots out in all directions.

Here is a box (Fig. 3) of 3 cubic feet capacity, including this spout, 9 inches square and 15 inches long, coming from the top of it; at the ends doors are arranged closed like steam-boiler man-holes; openings for light and bellows are arranged as in the previous box.

Here is a box, weighing 6 lbs., that will just slip over the spout; it has a rope lest it should strike the wall after the explosion. Placing now the lamp in the box, some dust in the corner, and the box over the spout, we are ready for another explosion. You observe, after blowing vigorously for a second or two, the dust in the box takes fire; the box over the spout is shot off, and rises until the rope (about 12 feet long) jerks it back; it strikes the stage with great force, rebounds, and clears the foot-lights, and would strike the floor below were it not for the rope.

I have thrown a box similar to this in the open air 20 feet high, while, as we shall see presently, less than an ounce of flour is being consumed.

I have fastened over the top of the spout five thicknesses of newspaper: upon igniting a boxful of dust as before, the paper is thrown violently into the air, accompanied by a loud report as it bursts.

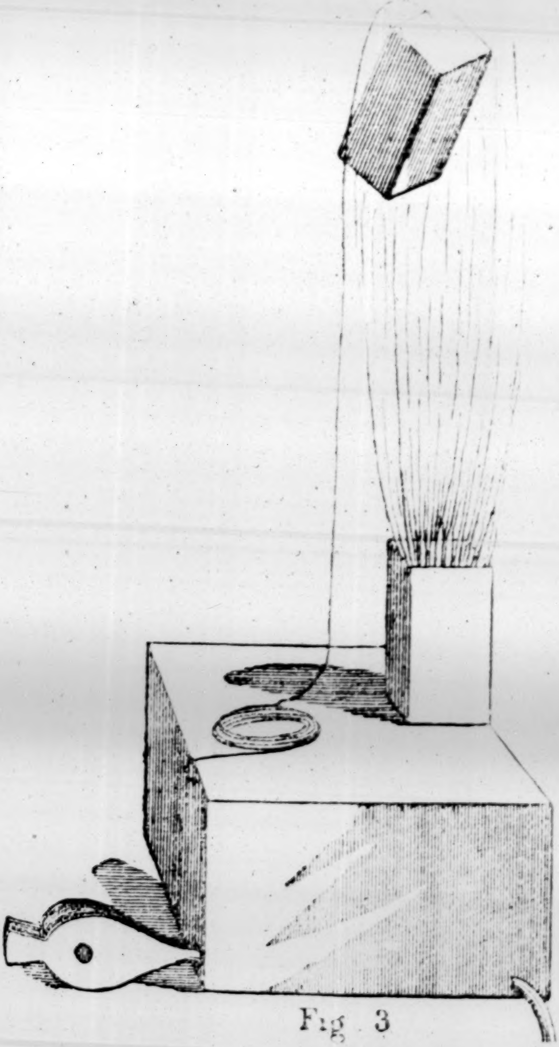

Fig. 3

For the last experiment I have a box of 4 cubic feet capacity (Fig. 4); five sides are $1\frac{1}{2}$ inches thick, the remaining side $\frac{1}{4}$ inch. Upon igniting the dust in this box, filled as in the other cases, the quarter-inch side bursts, and a stream of fire shoots out half-way across the stage.

One lb. of carbon and $2\frac{2}{3}$ lbs. of oxygen, when they combine to produce carbonic acid, will evolve heat enough, if it were applied through a perfect heat-engine, to raise 562 tons 10 feet high; if, therefore, 40 per cent of flour is carbon, it would require 2½ lbs. to accomplish this result, if an engine

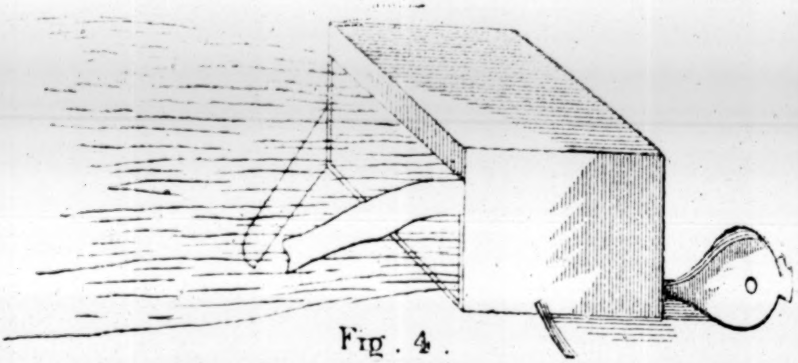

Fig. 4.

from which there would be absolutely no radiation, conduction, or loss of heat, in any way, were a practical possibility. Let us see how much air would be required to supply oxygen enough. Under ordinary conditions every 100 cubic inches of air contains 7·13 grains of oxygen, from which we find that 151½ cubic feet of air would be required for the 2⅔ lbs. of oxygen. Hence the 2½ lbs. of flour must be equally distributed as a dust through 151½ cubic feet of air, in order to produce the most powerful result.

If 41 ounces of flour require 151 cubic feet of air for perfect combustion, 1 cubic foot of air will supply oxygen enough for $\frac{40}{151}$ of an ounce of flour. Hence our box, which lifts the man so readily, burns ½ ounce of flour or less; and the other, which throws the box into the air, ¾ of an ounce, unless, as I think quite probable, an additional amount of air is drawn in through the cracks as soon as the vent is opened at the top of the box. In fact these experiments work better if a few small holes are made near the bottom of the boxes.

It may be worthy of mention here, as a point of interest to insurance companies, that in all dust-explosions a fire precedes the explosion in every case. The dust must burn before the heat that produces the immense expansive force is generated.

Too great precaution cannot be taken in all kinds of manufactories, where combustible dust is produced, against fire, especially in those establishments where it is conveyed in thick clouds by air-draughts through spouts and rooms.—*Popular Science Monthly.*

IV. ANOTHER VIEW OF THE ANTIQUITY OF MAN.

By Prof. B. F. MUDGE, Manhattan, Kansas.

WE were much interested with the article in the June number of the "Review" on the Antiquity of Man, by the Rev. J. L. Templin. He has very clearly and fairly stated the facts in the case, though we think he has left the question of the age of our race, in years, too indefinite.

We agree with him (and Dana) that man was on earth "at the close of the Glacial epoch, that he witnessed the retreat of the glaciers from Central Europe," &c. After the Glacial epoch, geologists fix three distinct epochs,—viz., the Champlain, terrace, and delta,—which have been considered of nearly equal lengths. The question then arises, have we no evidence to show the length of either of these periods?

There are facts which circumstantially give us a near approximation of the age of each, but they are nearly all based on considerations which only an expert geologist can appreciate. There are, however, in the delta period of the Mississippi, proofs which will give a very close approximation, in years, to the length of that epoch.

Various estimates have formerly been made for the time of the delta period, with varied results, Lyell and others placing it at least at 100,000 years, and others making it less. Further researches, extensively made, have confirmed Lyell's estimate. The most reliable evidence is as follows:—For a distance of about 200 miles of the delta are seen distinct forest growths of large trees, one over the other, with interspaces of sand,—showing distinct periods of the entire destruction of the forests, and, after burial, again a new generation of trees over the others. There are ten of these distinct forest growths, which have begun and ended one after the other. The outstretched, undisturbed position of the roots of the trees, as well as the other conditions of the deposits, show that they were not washed in, but grew on the spot.

Now if we can fix the time occupied by the life of these trees, we can give, at least, an approximate result. Fortunately the data are clear, and can be studied by any person of ordinary intelligence. The trees in question are the bald cypress (*Taxodium*) of the Southern States, one of the largest and longest of life of the world's trees. Specimens cut down in the present age are known to be from 5000 to 7000 years old. Humboldt saw one in Mexico of extremely large size, which he estimated—from counting the rings of smaller trees of the same species to be 8000 years old.

Such are the trees found in these old, buried forests of the delta of the Mississippi. Some of the old trunks were over 25 feet in diameter. One contained over 5700 annual rings. In many instances these huge trees have grown over the stumps or fallen trunks of others equally large. Such instances occur in all, or nearly all, of the ten forest beds. Dr. Dowler, one of the best physicians and scientists of New Orleans, saw such instances in many places, and concluded that each of the ten forest growths contained, on the average, two such trees of 5000 years each, living in succession. This gives to each forest a period of 10,000 years. Ten such periods give 100,000 years, without considering the time covered by the intervals between the ending of one forest and the beginning of another. The thickness of the intervening sand shows that this interval was not, in most cases, a short one.

Such evidence would be received in any court of law as sound and satisfactory, where common sense evidence is used. We do not see how such proof is to be discarded when applied to the antiquity of our race. If the antiquity of the mastodon was in discussion no one would doubt it. Human bones have been found in the fifth forest bed, and stone implements still lower. As Rev. Mr. Templin has stated, there is satisfactory evidence that man lived in the Champlain epoch. But the terrace epoch, or the greater part of it, intervenes between the Champlain and delta epochs, thus adding to my 100,000 years. If only as much time is given to both those epochs combined as to the delta period, 200,000 years is the total result.

There are other evidences in Europe, generally clear to the geologist, which sustain this long time for the antiquity of man.—*Kansas City Review of Science.*

V. THE FORMATION OF COAL.

THE paper read by M. Frémy, the eminent Director of the Museum at the Parisian Académie des Sciences, under the title "Chemical Researches respecting the Formation of Coal," is of such great interest that we have no hesitation in making it known to our readers.

It is known that coal is produced by the decomposition of vegetable matter, which for many ages covered the surface of the earth. The learned chemist has made a series of analyses, of which he gives an account in his paper, and which have enabled him to establish the laws of this decomposition, and to explain the transformation of the tissues of the vegetable matter into coal by the loss of their organic form.

With reference to peat, the hypothesis has been put forth generally up to the present time of a possible relation between their formation and that of coal. M. Frémy has been led by the same investigations to the conclusion that the peaty fermentation is, so to speak, the first stage reached by the ligneous tissues before arriving at their complete transformation into coal.

After making these short preliminary remarks, we hasten to introduce M. Frémy in his own words.

The paper, says M. Frémy, which I read to-day on the formation of coal is the latter part of the general investigations on the vegetable tissues which I have carried on since 1850, that is to say, since my nomination to the professorship of the museum.

It is at the Jardin des Plantes that I have found everything needful for pursuing my enquiries into certain matters highly interesting and important to chemistry and vegetable physiology.

The questions which I proposed to myself were as follows:—

What is the nature of the elements of which the organs and the tissues of vegetables are formed? Is it possible to discover these elements without altering them, and to determine with some exactness their proportions? Does this chemical analysis of the tissues permit of following the development in the vegetable organisation, and of establishing a comparison between them such as science demands? Is it possible for chemistry to make known the exact composition of these elements, at present but imperfectly defined, such as chlorophyllus gum, the gelatinous substances of fruits, which are found in a great number of tissues, and which certainly play an important part in the vegetable organisation? Lastly, will it be possible, when all these substances are understood, to determine under what influences the tissues of these vegetables are capable of being transformed into fossil fuel, such as lignite, coal, and anthracite?

Taking this programme as the basis of my researches, I shall make a rapid survey of those investigations by which I sought to establish the nature and composition of those substances forming the skeleton or framework of vegetable matter.

The organic elements which I first examined were but little known. Their characteristic property is to produce, under the influence of fermentation or by the action of chemical reagents, a series of gummy and gelatinous substances. They may be confounded with the cell-walls themselves when they are merely subjected to microscopical examination. They often join the cells together, as is shown in the tissue forming the pith of the elder tree. I have demonstrated that the gelatinous substances of vegetables are derived from a primal insoluble substance which I have named *pectose*, and which, by successive polymerical transformations, forms at first gummy substances, then gelatinous bodies, and lastly a soluble acid, the strength of which may be compared with that of the acids found in fruits. All these transformations are produced during the growth of the vegetation.

M. Frémy then undertook the investigation of the properties and nature of the stable and fixed bodies forming the fibres, the cells, and the ducts. From these researches it results that the vegetable framework is not so simple as was commonly supposed. It is not constituted of a single substance, the cellular variously incrusted with foreign substances, but of several kinds of isomeric cellular substances. In addition to this, a very important body is also met with, which differs from the cellular in respect to its composition and properties, a body which runs abundantly in the ducts, and which M. Frémy has for this reason called *vasculose*. It is this substance which causes the hardness and density of the ligneous tissues to vary according to the proportion in which it is contained. Oak may contain 30 per cent of it, and as much as 50 per cent may be found in nutshells. The *vasculose* is placed between the walls of the fibres and the cells, and unites them. It is dissolved by caustic alkalies.

After these internal tissues M. Frémy studied the bodies which cover and protect them, such as the cuticle. He called by the name of *cutose* the substance which forms the cuticle, and which is even found in cork. It is remarkable for its fixity, and is scarcely affected by sulphuric acid. Lastly, to complete this general study, the learned Director of the Museum examined those bodies which are most frequently met with in the tissues. Gum, for instance, is not a neutral substance, as has been commonly supposed, but a veritable salt, resulting from the combination of a genuine acid with lime. The chlorophyllus itself is not a neutral substance. It is formed of a bluish-green alkaline salt, phyllocyanate of potassa.

These preliminary researches being concluded, M. Frémy placed the top stone to the edifice by attempting the solution of the difficult and interesting problem of the formation of fossil fuel. If vegetable palæontology has made such great progress in these latter times, it may be said that the chemical part of the question has remained in absolute darkness. We know not under what influences the vegetable organisation has been destroyed to form this black bituminous mass, partly fusible, non-organic, and insoluble in dissolvents, which constitutes coal. This substance neither resembles the pyrogenous bodies produced in our laboratories nor the ligneous tissues which have formed it. By distillation it gives forth volatile products which do not resemble those given by wood. It leaves also, as a fixed body, a special substance called coke, which is very different from charcoal.

Having already introduced this question in a previous paper, M. Frémy mentioned several chemical reactions which characterised wood, peat, lignite, coal, and anthracite. Wood is not perceptibly affected by a diluted solution of potassa, whereas peat often renders to this alkali considerable quantities of ulmic acid. Xyloide lignite, or fossil wood, also contains notable proportions of ulmic acid; but it is not to be confounded either with wood or with peat, because it is transformed into yellow resin by nitric acid, and is completely soluble in hypochlorites. Compact or perfect lignite does not contain any sensible quantity of ulmic acid, but is soluble in nitric acid and hypochlorites. With respect to coal and anthracite, they are characterised by their insolubility in all the neutral solvents, acids, alkalies, and hypochlorites.

The experiments of M. Daubrée upon anthracite, and the no less interesting experiments of M. Baroullier upon coal, lead us to think that the transformation into coal is brought about by the action of heat and pressure upon the vegetable matters. In order to analyse the phenomenon, M. Frémy arranged a series of tests, in which the vegetable tissues, on the one hand, and, on the other, those substances which most frequently accompany them in the organisation, were heated to between 200° and 300° for some hours in glass tubes sealed at both ends.

In these experiments M. Frémy observed a great modification. The tissues became black, brittle, and free from water, acids, gas, and tar; but they retained their original organisation, and furnished a fixed product, offering no resemblance to coal.

The learned academician then submitted to the same test a certain number of bodies produced by organism, such as sugar, starch, gum, &c., and arrived at very different results. These bodies were transformed into substances having a certain analogy to coal: they were black, shiny, often melted, and quite insoluble in acids and alkalies.

The analysis of these bodies, which M. Frémy designates by the name of coally substances, has demonstrated the complete analogy of their composition with that of natural coal. Coal from gum gives in analysis almost the same quantities of carbon, hydrogen, and oxygen as natural coal.

From these coincidences of composition M. Frémy draws the conclusion that the elements contained in the vegetable cells—such as sugar, starch, and gum—play an important part in the production of coal.

This result was doubtless a very interesting one; but, in order to complete it, it was necessary to explain how the tissues of vegetables could lose their organic form and produce the amorphous mass called coal. Besides this, also, it was necessary that the tissues should be proved to be capable of undergoing the same coal transformation which was realised by operating upon the non-organic bodies which accompanied them.

The studies of the eminent chemist with respect to lignite and peat now proved of great assistance to him. He had seen in these combustibles the ulmic acid appear in proportion as the ligneous tissues lost their organisation. When a peat was advanced he only found insignificant remains of organic tissue, but then it contained from 50 to 60 per cent of ulmic acid. On examining the fossil wood M. Frémy found pretty thick, black, and shining layers of ulmic acid proceeding from the transformation of *vasculose* besides the ligneous fibres, which were not yet completely disorganised.

This observation demonstrated the transformation on the spot, and in the ligneous tissue itself, of a part of the wood into ulmic acid. In this way M. Frémy was led to admit the fact which appeared to predominate in his researches, that the vegetable matter was first changed into peat before producing coal, and that in this modification the disappearance of the organic tissues was owing to a kind of peaty fermentation. To confirm this hypothesis he found it necessary to prove that the ulmic acid could, like the bodies previously experimented upon, be transformed into coal.

In consequence M. Frémy studied the transformation of three kinds of ulmic acid, and discovered that, after a calcination of 120 hours, the ulmic acid of the peat was converted into artificial coal, presenting the same composition as the coal of Blanzy.

Lastly, the mixtures of chlorophyllus, fatty bodies, and resins obtained from leaves by treating them with alcohol, when submitted to the same operation,—that is to say, heated under pressure for 150 hours,—produced a black, viscous, odorous substance, insoluble in alkalies, and presenting an evident analogy with natural bitumen.

From these facts M. Frémy draws the following conclusions:—

1. Coal is a substance which proceeds from the transformation of vegetable matter, but which no longer preserves its organic form.

2. The vegetable marks which the coal presents are produced by it, as in schist or other mineral substances, and do not prove its organisation. This fuel is a bituminous and plastic matter, on which the external features of the vegetation are moulded. When a piece of coal presents on its surface, or within its interior, marks of vegetation, it is not to be thence inferred that the adjacent parts are necessarily the result of the alteration of the tissues which were covered by the membranes whose form has been preserved.

3. The principal bodies contained in the vegetable cells, submitted to the double influence of heat and pressure, produce substances which present the properties and composition of coal.

4. The colouring, resinous, and fatty matters contained in the leaves are changed, by the action of heat and pressure, into substances which approach very nearly to natural bitumen.

5. With regard to the ligneous tissues at the base of the

cellulose and the *vasculose*, they are not transformed directly into coal. Before being so changed they pass through a process of peaty fermentation, which produces ulmic acid. It is only in the second place that this ulmic acid is transformed into coal, mingling with all the coal-forming substances produced by the contents of the cells.—*The Colliery Guardian, being translated from L'Houille.*

VI. THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Sheffield Meeting, August, 1879.

(Continued from p. 641.)

AFTER the delivery by Prof. Johnstone Stoney of his admirable Address to Section A, an abstract of which concluded our report in the "Monthly Journal of Science" for September, the Report of the Committee—consisting of Prof. Sir William Thomson, Prof. Clerk-Maxwell, Prof. Tait, Dr. C. W. Siemens, Mr. F. J. Bramwell, and Mr. J. T. Bottomley—for commencing Secular Experiments upon the Elasticity of Wires, was read by Mr. Bottomley. The most important of the experiments conducted during the past year are those that have been made on the elastic properties of very soft iron wire. The wire used was drawn for the purpose, and is about No. 20 B.W.G., its breaking weight, tested in the ordinary way, being about 45 lbs. This wire has been suspended in lengths of about 20 ft., and broken by weights applied, the breaking being performed more or less slowly. During the breaking it was found that the wire becomes alternately more or less yielding to stress applied. Thus, from weights applied gradually, between 28 lbs. and 31 lbs. or 32 lbs., there is very little yielding and very little elongation of the wire. For equal additions of weight, between 33 lbs. and about 37 lbs., the elongation is very great. After 37 lbs. have been put on the wire seems to set stiff again, till a weight of about 40 lbs. has been applied; then there is rapid running down till 45 lbs. has been reached. The wire then becomes stiff again, and often remains so till it breaks.

The Report of the Committee for making more accurate determinations of the mechanical equivalent of heat stated that the work in progress was the protracted one of supplying a means of correcting errors in the determination of the temperature arising from the temporary changes of the fixed points of thermometers constructed of glass. An extensive series of experiments had recently been made by Prof. H. A. Rowland, of Baltimore, who, being unaware of what had been done by the Committee, had arrived at an equivalent almost identical with that determined by Mr. Joule.

The Report of the Committee for procuring Reports on the Progress of Mathematics and Physics contained two communications to the Committee, the one from Prof. Clerk-Maxwell, F.R.S., and the other from Prof. Stokes, F.R.S., giving their opinions on the questions with which the Committee has to deal.

The Twelfth Report of the Committee on Underground Temperature was read by Prof. J. D. Everett, F.R.S. One of the methods employed for taking underground temperatures is the lowering of maximum thermometers into deep bore holes filled with water. Another mode is to take observations in mines and collieries of the readings of very slow-acting thermometers. The experiments referred to include those of Dr. Stapff, made in the St. Gothard Tunnel. The mean temperature gradient for the whole length of the tunnel (about 9 miles), was found to be 1° F. for every 88 feet, but Dr. Stapff found that where the surface of the upper ground is a steep ridge the temperature gradient is less rapid than that, which is quite consistent with the hypothesis that the earth was at one time very much hotter than it is now, and that it is undergoing a process of cooling down.

The Report of the Committee on Atmospheric Electricity in Madeira was read by Dr. M. Grabham. Observing the regular winds and breezes, Dr. Grabham traced the steady rise of electricity in the early morning to a maximum at 11.30 a.m., which declines after much steadiness for two hours, at first suddenly, and then very gradually towards night.

The Report of the Committee on Luminous Meteors—read by Mr. James Glaisher, F.R.S.—dealt in detail with the accounts of conspicuous detonating fire-balls that had occurred in the United States on August 11th and December 18th, 1878, and on January 27th, 1879; in Bohemia and Saxony on January 12th, 1879; and in England on February

22nd and 24th, 1879, the real paths of all of which had to a greater or less degree of certainty and closeness been approximately ascertained. A description of the past year's aërolites was also given. The expected return of Biela's comet to its perihelion in the present year, leading a shower of shooting stars to be looked for on the 27th of November next, is to be taken advantage of to report next year on meteor showers.

The Report of the Committee on Instruments for Detecting Fire-Damp in Mines was read by Professor G. Forbes, F.R.S.E. Two new instruments have been constructed: the one of a large size, and worked by an electric battery; the other was small, portable, easily worked, and it answered all the purposes for which it was required. Both instruments were founded upon the facts that sound travels quicker in light gases than in dense ones, and that air which is contaminated with fire-damp is lighter than pure air. The velocity of sound in different qualities of air was compared by noting the lengths which must be given to a brass tube to cause it to resound to a tuning-fork. The accuracy of the instrument was such that the percentage of fire-damp could be determined with an error of considerably less than one per cent. The committee had descended the Wharncliffe Silkstone Colliery, in the neighbourhood of Sheffield (this pit has a depth of 200 yards), and were taken to a disused part of the mine where it was known there was a blower. Gas in sufficient quantities were found, and the instrument registered gas with more readiness than the Davy lamp. But the greatest quantity registered was 6 per cent, or twelve times the smallest quantity which the indicator detects. From the experiments they could assert that this instrument was capable of detecting and measuring fire damp even in small quantities.

The paper which, perhaps, attracted the most attention in Section A was that by the Rev. S. Earnshaw, M.A., on "Etherspheres as a Vera Causa of Natural Philosophy." In defining the term "ethersphere," Mr. Earnshaw said all space not filled by matter is pervaded by ether, so that every atom of matter is surrounded by ether, but this is not what is included in the word "ethersphere." If any portion of space be rendered void by ether from any cause whatever, that space has become void of the repulsive forces which were centered within it, and that, consequently, when these forces are taken away the medium outside the space will draw closer towards that space; and if the space be occupied by an atom of matter, the density of the surrounding ether will be greater than before, and the ether, being in contact with the atom at its surface, will press upon it. The *excess* of ether about the vacant space above its original quantity constitutes the ethersphere; and though this gathering together of ether about the space now occupied by the atom is a consequence of the presence of the atom, it is in no way owing to its action on the ethereal medium. Mr. Earnshaw then argued that if every material atom, so must every compound system of atoms, *i.e.*, every material body, whether gaseous, liquid, or solid, have an ethersphere, which not only surrounds the whole body, but also penetrates the interstitial spaces of the body which lie between its atoms. By means of these etherspheres the author believes the phenomena of heat may be satisfactorily accounted for, on the supposition that the ethereal medium is the medium of heat as well as of light. He therefore concludes that etherspheres constitute a *vera causa* the existence of which in Nature is as certain as is that of the ethereal medium itself, about which no philosopher expresses doubt in the present day.

Mr. Gordon read a paper on "Secular Changes in the Specific Inductive Capacity of Glass." Mr. Gordon's experiments have led him to the conclusion that in the course of a year and a half an actual change had taken place in the glasses he used, which was shown by a considerable real increase in their specific inductive capacities. These experiments had some importance as regards Prof. Clerk Maxwell's electro-magnetic theory of light. In a recent lecture he (Mr. Gordon) had suggested that it was quite possible that the relation between electric induction and light exists—namely, that they are disturbances of the same ether, but that there is some unknown disturbing cause affecting the electric induction. Possibly a clue to the nature of this disturbing cause may be found in the fact that the specific inductive capacities were affected by some of the changes which chemists assert are constantly going on in glasses, but that these changes do not affect the refractive indices.

Prof. Johnstone Stoney read a paper "On the Cause of Bright Lines of Comets." Dr. Huggins and others had seen the bright lines of the carbon spectrum in the spectra of several comets. This established the fact that some compound of carbon was present in comets. Mr. Stoney suggested that the bright lines were due, not to the incandescence of the carbon compound, but to the sun's light falling upon the compound of carbon and rendering it visible, in the same way that light renders the moon, the planets, and other opaque objects visible, the vapour of carbon being opaque in reference to the particular rays, which appear as bright lines in its spectrum.

Dr. Janssen, Member of the Institute of France, and Director of the Observatory, Meudon, read a paper "On Photographic Spectra of Short Exposure," in which he showed that in the solar spectrum the point of maximum actinic intensity was near the line G, while the point of maximum luminous intensity was near D. It occupied sensibly the same position for nearly all photographic substances and for lenses of different material. The time of exposure was graduated from five minutes to a small fraction of a second. By this means results were obtained which practically afforded a chronometric method of analysis of the solar spectrum. They had a bearing on the question of oxygen in the sun, and they led to practical improvements in the construction of photographic apparatus.

Mr. H. Courtenay Fox read a paper "On the Synchronism of the Mean Temperature and Rainfall in the Climate of London. The paper was accompanied by copious tables exhibiting the months and seasons for sixty-seven years, arranged in the order of their respective temperature and rainfall as for the Royal Observatory. The following is a short summary of the results:—1. In each of the four months from November to February, extreme cold tends to be synchronous with dryness, warmth with large rainfall. 2. In the summer months, June to August, cold tends to be accompanied by much rain, warmth by dryness. 3. To put this in popular language, rain brings warmth in winter and cold in summer; that is (if rain be the cause, which is by no means proven) it mitigates the special character of each extreme season, winter and summer. 4. Very wet years tend to be either cold or warm, whilst years of drought tend to assume an average temperature.

A paper "On Lightning Protectors for Telegraphic Apparatus" was read by Mr. W. H. Preece. For many years it was not the practice in England to protect telegraphic apparatus from the injurious effects of atmospheric electricity because the damage done was so insignificant, and because the remedy was found to be worse than the disease. But as telegraph systems increased lightning protectors became essential. Many forms were tried based on the fact that when a discharge takes place through a non-conductor, such as dry air, at the moment of discharge the resistance along the line of discharge is practically nothing, and therefore all the charge is inducted away. Most of those tried failed. The survival of the fittest has been exemplified in the "plate" protector. In this form—one of the earliest introduced—one thick plate of brass is in connection with the earth, and another similar plate in connection with the line is placed above it, but separated from it by paper or by insulating washers. The lightning entering the wire, bursts across the paper or air-space in preference to passing through the apparatus, and thus escapes to earth. It is the practice of the Post-Office department to keep these plates apart by thin paraffined paper 0·002 inch thick. The paper contains an account of some important experiments by the author on plate-protectors, which confirm very decidedly the accuracy of the figures obtained by Drs. Warren de la Rue and Müller on the striking distance between two flat disks given by them in a paper read before the Royal Society.

SECTION B.

The Chemical Section (B) was presided over by Professor Dewar, F.R.S., who, in his opening Address, remarked that the time was past when the President could give a review of Chemical Work from year to year, so he took a broad view of the progress of Chemical Science. Referring to Messrs. Thomas and Gilchrist's process for the elimination of phosphorus from pig-iron, Prof. Dewar said that by far the greater portion of iron ores contain very appreciable quantities of phosphorus. Of the total phosphorus which goes into a blast-furnace, whether with the ore or with the limestone, nine-tenths are contained in the resulting pig-iron. The Bessemer process did not eliminate phosphorus from pig-iron treated by it, and extremely small proportions of phosphorus render steel "cold short," so that the process had hitherto only been applicable to the rarer and costlier kind of pig-iron produced from exceptionally pure ore. Even thus restricted the Bessemer process had produced results of incalculable importance, and the imagination could scarcely grasp the extent of the further development it must receive and the importance of the further benefits which must now flow from it.

We have not sufficient space to refer to the many valuable papers brought before this Section. We must, however, mention a note by Mr. J. Norman Lockyer, "On the Supposed Compound Nature of the Elements." Continuing his researches on this subject, he found that when carefully distilled metallic sodium is condensed in a capillary tube, placed in a retort, and heated in a Sprengel vacuum, it gives off twenty times its volume of hydrogen. Phosphorus, carefully dried, gives off 70 volumes of gas, chiefly hydrogen. A specimen of magnesium, carefully purified by Messrs. Johnson and Matthey, was magnificent in its colourings; it gave first hydrogen, then the D line, then the green lines of magnesium (*b*), then the blue line, and then, as the temperature was increased, various mixtures of all of them, the D line being always the most brilliant. In this experiment only two volumes of hydrogen were collected. From gallium and arsenic no gas is given off. From sulphur and some of its compounds sulphurous anhydride was always obtained. From indium, hydrogen was given off before heating; while from lithium no less than 100 volumes of hydrogen were given off.

Dr. Gilbert, F.R.S., read a paper "On some Points in connection with Agricultural Chemistry," in which he stated that Mr. Lawes, at Rothamsted, and himself, had now grown wheat for 36 years in succession on the same land, barley for 28 years in succession, oats for 10 years, root crops for more than 30 years, beans for more than 30 years, and they had experimented with mixed herbage on grass land for 24 years. They found only minor distinctions in the manurial requirements of different plants of the same natural family, but very great distinctions in the requirements of plants of different natural families. The gramineous crops are very low in the percentage of nitrogen, and yield but a very small quantity per acre. Yet nitrogenous manures are very effective when applied to such crops. Leguminous crops, on the other hand, are very high in the percentage of nitrogen, and yield a very large amount of it per acre. Yet nitrogenous manures are of little avail to these plants, and potash manure is especially effective. The differences in manure requirements of plants of all natural families were also pointed out. Much more complicated, however, was the problem when experiments were made upon mixed herbage of grass land, where they might have fifty or more species growing in association, representing perhaps twenty natural families. One point of especial interest was the difference in the amount of nitrogen yielded by the plants of the different natural families. It was assumed by some that some plants assimilated the free nitrogen of the atmosphere; but so far as existing evidence went the author considers it much more probable that the soil is the source of the combined nitrogen. Experiments show that by the growth of wheat or barley for many years in succession on the same land without nitrogenous manure, the annual yield of nitrogen in the crop gradually diminishes. There was also a diminution in the percentage of nitrogen in the soil. In the case of the root crops the diminution in the percentage of nitrogen in the soils was also greater. With beans there was also a diminution in the yield of nitrogen in the crop, but still much more was yielded, even at the conclusion, than with either wheat or barley. In these cases there was not found a reduction of nitrogen in the soil. In the case of mixed herbage experiments, very much more nitrogen was yielded by the application of potash manure, and here there was a great reduction in the percentage of nitrogen in the soil. The percentage of nitrogen in the soil was also very largely reduced in the case of clover grown for many years in garden soil. Part of this reduction might be due to other causes, but the indication was that the Leguminosæ had derived their nitrogen from the soil. Admitting that the sources of the whole of the nitrogen of vegetation were not conclusively made out, he nevertheless considered that the existing evidence was against the idea of the assimilation of free nitrogen by plants, and in favour of an opinion that free nitrogen was mainly, if not entirely, derived from the soil.

SECTION C.

The President of the Geological Section (C), Professor P. Martin Duncan, in his Address, said that of all the geological formations the carboniferous gave the earliest clear and definite idea of a land surface on the earth, or rather of the existence of many lands. In reflecting upon the history of the carboniferous deposits, in relation to the subsequent great changes in the physical geography of the earth, the idea that geological histories repeated themselves did not obtain that importance with which it is credited in relation to human events. It was true that there were extensive triassic, oolitic, wealden, neocomian, and tertiary lands, whose vegetation had been metamorphosed into a kind of coal; but the wonderful depth, and the extraordinary vertical repetition of organic and inorganic deposits of the carboniferous formation, and the remarkable crust movements which enabled them to accumulate, were without subsequent examples.

The Sixth Report on the Conductivities of Coral Rocks, prepared by Prof. A. S. Herschell and Prof. G. A. Lebour, was read. The research and correspondence necessary to complete a historical sketch of the attempts hitherto made to determine experimentally the thermal conductivities of the terrestrial rocks most widely distributed, which the Committee had proposed to draw up during the past year, were not so far advanced at present as to allow them to be comprised in this year's report. The Committee hopes, by continuing its inquiries for another year, with the addition to its number of Prof. W. E. Ayrton and Mr. J. Perry, of the Imperial College of Engineering in Japan, to carry out the object of their undertaking, so as to exhibit our existing knowledge of the date of thermal conductivity of those widespread kinds of rock which constitute the external materials of the globe.

The Fifteenth Report of the Committee for Exploring Kent's Cavern, Devonshire, was read by Mr. W. Pengelly, F.R.S. He observed that this was probably the last report he should present on the subject, as the exploration work was fast drawing to a close. Work during the past year has been carried on in the "High Chamber" and its branches. This "High Chamber" contains only breccia, the oldest mechanical deposit in the cavern, and the crystalline stalagmite which overlies it. Bones of bears and implements have been found in the breccia here, and also in that of the southern branch, called the "Swallow Gallery."

SECTION D.

The Biological Section was presided over by Professor St. George Mivart, F.R.S., who, in his Presidential Address, referred to the life and labours of Buffon, noticing his speculations concerning animal variation; his belief in the direct effect of the surrounding circumstances on organisms; and also his belief that new species have arisen by degradation. We may, Prof. Mivart thought, accept as true two propositions:—(1.) Animals may change in various ways, and amongst them, by degradation. (2.) Changes in the environment with isolation, induce and favour changes in form. He urged that inquiries should be pursued in two directions simultaneously. (A.) There might be undertaken one set of inquiries to investigate the effects on different species of the same variation of environment. (B.) Other inquiries might be undertaken with a view to ascertaining the effects of different changes of environment on one and the same species. The President then directed attention to the resemblances and differences which exist between the mind of man and the higher physical faculties of animals.

In the Department of Anatomy and Physiology the President was Dr. Pye-Smith, F.R.S., whose address attracted great attention. Biology, he remarked, is the science of the structure, the functions, the distribution, and the succession in time of all living beings. If the proper study of mankind be man, he has learnt late in the inquiry that he can only understand himself by recognising that he is but one in the vast network of organic creation; that intelligible human anatomy must be based upon comparative anatomy; that human physiology can only be approached as a branch of general physiology, and that even the humblest mould or sea-weed may furnish help to explain the most important problems of human existence. Speaking of the relation of physiology to the national health Dr. Pye-Smith said that if the art of keeping a community in health is but the application of plain physiological laws, it is no less true that the art of restoring the health, curative as distinct from preventive medicine, rests upon the same basis. We now know that disease is, as the name implies, a purely subjective conception. The disease of a host is the health of the parasite, and we cure a human sufferer by poisoning the animals or plants which interfere with his comfort. The same changes which in the old man are the natural steps of decay, the absence of which after a certain age would be truly pathological, are the cause of acute disease in the young. Pathology has no laws distinct from those of physiology. It clearly follows that all "systems of medicine" are in their very nature condemned. All that the art of medicine can do is to apply a knowledge of natural laws, of mechanics, and of hydrostatics, of botany and zoology, of chemistry and electricity, of the behaviour of living cells and organs when subjected to the influence of heat and of cold, of acids and alkalies, of alcohols and ethers, of narcotics and stimulants, so as to modify certain deviations from ordinary structure and function which are productive of pain, or discomfort, or death. Rational medicine, or keeping right and setting right the human body, must therefore rest upon a knowledge of its structure and its actions, just as a steam-engine or a watch cannot be mended upon general principles, but only by one who is familiar with their construction and working, and who can detect the source of their irregularity. With regard to the endowment of research in biology, Dr. Pye-Smith confessed that he should be sorry to see it undertaken by Government funds. This country is not so poor, nor our countrymen so wanting in public spirit, that we need appeal to the national purse to supply every ascertained want. Great as is the national importance of science, the nation was more important still; and even if that were the alternative he would rather that we should indefinitely continue dependent on Germany for our knowledge than give up the local energy, the unofficial zeal which has made England what she is. Coming to Vivisection Dr. Pye-Smith referred to the reasons which animate much of the opposition to Vivisection, many of which we have discussed in the "Monthly Journal of Science." With regard to the recent legislation he said that a system of licenses and certificates, revocable at the will of a Minister who may, by the accidents of party, be at any time amenable to anti-scientific influences, adds serious difficulties to those already in the way of experiments. As an illustration, he asked his audience to suppose that certain persons opposed on various grounds to learning, and especially hostile to Greek, had attacked the study of Plato. They would point out the danger of modern ladies becoming as well read in his writings as was Lady Jane Grey. They would show that the laxity of modern manners was coincident with the popularity of the "Symposium," and that the notorious increase of infanticide was the result of the teaching of the "Republic." Associations for the total suppression of Plato would be formed, with hired advocates, and anonymous' letters, and "leaflets," spreading a knowledge of his most objectionable passages. Scholars would be threatened with eternal punishment, and schoolmasters with the withdrawal of their pupils. Then a royal commission would be appointed—a great Latin scholar, a Whig and a Tory statesman (who, having taken a B.Sc. degree at Oxford would be impartially ignorant of Greek) the most intelligent despiser of Plato who could be found, the master of a grammar school on the modern side, and (perhaps the most efficient of all) a lawyer, who knew nothing about Greek but hated cant. This commission would take evidence that the Platonic writings were not all immoral, that they had been quoted with approval by Fathers of the Church, that they were of great importance to literature and philosophy, and even to the elucidation of the Sacred Writings. It would also be proved that the Platonic Dialogues were far less immoral than multitudes of other widely circulated books, or than a French novel which one of the royal commissioners happened to be reading, and, lastly, that the morals of Greek scholars, and of clergymen who had read Plato at college, were not obviously degraded below those of other people. On the other hand, witnesses would depose that a knowledge of Plato was of no consequence to a student of philosophy: that if it were, the text was in so corrupt a condition that no two scholars agreed as to a single chapter, and that, after all, philosophy was of no practical use, least of all to clergymen. Others would affirm that though they had never read a line of him, they knew that his style was as vicious as his sentiments; and perhaps some cross-grained scholar might be found who, having once edited a play of Euripides, would declare that all studies in Greek literature ought to be restricted to the tragedians, and that for his part he had never opened any other authors, and had never felt the want of them. At last the commission would report that there was no question of the value of the works of Plato, that it would be mischievous and impracticable to prohibit their study, and that there was no evidence that schoolmasters habitually chose the least edifying passages as lessons for boys. Then what is called a compromise would be made. It would be enacted that Plato might be read, but only in colleges annually licensed for that purpose; that every one wishing to read must have a general certificate signed by certain professors, and setting forth his object, also to be renewed every year; and that special certificates might be severally obtained for reading certain excepted dialogues, for copying from them, for publishing them, or, in rare cases, for translating them. However reasonably such a system might be administered, who can doubt the result would be a diminution of the number of scholars, and a check to the progress of learning? Now this is what legislation has done for physiological experiments. The Act (39 and 40 Victoria) was hastily drawn and hurriedly discussed; for noble lords and honourable gentlemen who had been taught from childhood to vivisect for unscientific purposes were eager to hurry off to their own merry vivisections, for which they were ready provided with licence and certificates. And it works as might be expected. Some shrink from seeing their names figure in disreputable newspapers, and receiving more or less savagely abusive anonymous letters. Others have no laboratories, and find difficulty in licensing their houses. Others are refused the certificates they require. In one case two thoroughly qualified men were anxious to carry out an important investigation on the treatment of snake-bites. They procured venomous snakes from a distance, and applied for the special certificates necessary. Considerable delay ensued; various objections were raised, and set at rest; and at last all the certificates were obtained; but meantime the snakes had died."

In the Department of Botany Sir John Lubbock read a paper on "Seeds." He directed attention to the difference in seeds, some being large, some small, some covered with hooks, some provided with hairs, some smooth, some sticky, &c. Many seeds required protection from birds and insects, hence the shells or husks of the beech, Spanish chestnut, horse chestnut, walnut, &c. In some cases, as in the common herb, the calyx closed over the seeds when the flower faded, and opened when the seeds were ripe. In other cases the flower stalk changed its position. The modes of dispersion by means of which seeds secured a sort of natural rotation of crops, and were also in other cases enabled to rectify their frontiers, were also described. Some plants threw their seeds. Among the higher plants the seeds were transported by the wind. Many seeds were provided with a wing which caught the wind, and these and kindred aids in dispersion were as various as the plants themselves. The dispersion was often effected by the agency of animals. In some cases the action of animals was involuntary, and these might be divided into two classes, those in which the seeds adhered to animals by hooks and those in which this was effected by sticky glands. The seeds of a South African plant, provided with hooks more than an inch long, were said sometimes even to destroy lions. They rolled about on the sandy plains, and if a seed attached itself to the skin the wretched animal tried to tear it off, and getting it into his mouth was fatally injured. Sir John, in conclusion, called attention to mimicking seeds, such as the scorpiurus, the pods of which did not open, but looked so exactly like worms that birds were induced to peck at them, and thus the seeds were freed.

A paper on the effects of the frosts of 1860-61 and 1878-79 on vegetation was read by Mr. E. J. Lowe, F.R.S., from which it appeared that the greatest cold of 1860 exceeded that of last winter by 10 degrees, being 6 degrees below zero in 1860, whilst it was 4 degrees above zero during the late frost. Instead of the cold killing the slugs and various pests of plants they were never known to be so numerous. Many hardy plants in pots were killed when they escaped if planted in the ground.

SECTION F.

We must not omit a notice of two papers brought before the section of Economic Science and Statistics, the one by Dr. J. H. Gladstone "On Elementary National Science in Board Schools;" the other by Prof. Leone Levi "On the Scientific Societies in Relation to the Advancement of Science in the United Kingdom."

Dr. Gladstone pointed out that in elementary schools a knowledge of the facts of nature is generally given in two very different ways. In the infant department there usually lingers some remnants of that instruction by object lessons which was considered a valuable part of education before the Revised Code of 1861. In the higher standards of the boys' and girls' departments certain sciences may be taught as "specific subjects," and receive encouragement by a Government grant. At the present time out of 1074 male and 1790 female teachers, 888 males and 442 females hold advanced science certificates, varying in number from 1 to 23. Advanced object lessons, generally on natural history, are taught in many of the boys' and girls' departments, and there is little doubt that they will soon become much more general and systematic. Out of 248 boys', 218 girls', and 46 mixed schools, more than half include in their course of instruction scientific specific subjects. The cost of books and apparatus for the instruction in natural knowledge during the past twelvemonth was £834. This amount is rather less than one penny per child per annum.

Mr. J. F. Moss advocated the establishment of centres, at which this class of work could be done by selected teachers and under far more favourable conditions than at present existed. Branches of science more immediately bearing upon the industries of each district should have special prominence so as to aid in the training of intelligent artisans, foremen, and managers instead of depending so largely for the supply of educated men from other countries where greater attention had been given to technical education with such important results.

Prof. Silvanus Thompson advocated apprenticeship schools, but if such schools were established in England it should be by local rather than Imperial effort, for they succeeded better when they were not fettered by Imperial legislation.

The President (Mr. Mundella) believed that science teaching tended to redeem school life from its drudgery and monotony. In the science schools abroad the interest manifested by the children in a proper object lesson and the facility with which they acquired knowledge had very much struck him.

In his Address on Scientific Societies, Prof. Leone Levi said that in the seventeenth century there were only two scientific societies in this country, but at the present time the calendar exhibited an amount of activity quite unknown at former periods. In 1878 the number of members for the Royal Society was 549; for the Royal Society of Edinburgh, 429; and for the Royal Irish Academy, 328. The societies devoted to physical and mathematical sciences had, in 1878, 5406 members; the natural history sciences, 16,534; the archæological and geographical societies, 5038; and the societies whose object is the study of the applied sciences, 21,947. The amount voted by the State in 1878 for education, science, and art amounted to £4,153,000. If, however, they eliminated from the total vote the amount expended for elementary education, the proportion left for science and art was considerably diminished, amounting only to £529,000. Government aid was principally given to physical and natural science, leaving a wide range of scientific exploration altogether unassisted. It was not to be desired that Science should be subsidised by the State, but the claim of Science had been fully recognised.

The Chairman (Mr. Shaw Lefevre, M.P.) agreed with the speakers that the multiplication of members of scientific societies did not necessarily indicate the growth of excellence in Science and an increase in the number of scientific men. They really required some standard, for there was no doubt that the members of some learned societies placing so many letters after their names was just an indication that they could subscribe a certain number of guineas in the year. The Royal Society had taken a step in the right direction in limiting the number of its Fellows. He always thought the letters "F.R.S." a much greater distinction than "M.P.," for it was impossible that that honour could be acquired except by the possession of great and solid attainments.

SECTION G.

The President of the Mechanical Science Section (Mr. J. Robinson) chose for the subject of his Address the "Development of the Use of Steel during the last Forty Years, considered in its Mechanical and Economic Aspects." Referring to the enormous reduction of price, and consequent more frequent and more economic application of steel, the President said that, following the initiation of Krupp, our

English engineers and men of science set themselves to work to discover and apply new processes for the production and manufacture of this most wonderful metal; and in the whole history of metallurgy, from the time of Tubal Cain downwards, there has been no such progress in invention and manufacture as has been realised by the aid of such men as Mushet, Krupp, Bessemer, Siemens, Whitworth, Martin, Vickers, Bell, Bauschinger, Styffe, and many others within the last forty years.

An important paper was read by Captain Bedford Pim, "On the proposed Canal across the Isthmus of Panama." He estimated that the canal would not cost more than ten millions.

A paper "On Leon Francq's Fireless Locomotive" was read by M. C. Bergeron. The idea of such a locomotive was originated at the time of the horse plague in New Orleans, in 1872. After the Franco-German war M. Francq, who was connected with the Paris tramways, gave his attention to discovering a motive power for his tram-cars. The object he had in view was in obtaining such heat from water as would supply the motive power he needed. The engine in question was the result of his investigations. It had a large cylindrical reservoir, surmounted by a steel dome, two cylinders acting with piston rods, and a crank carrying two driving wheels, which were connected with other two wheels. The reservoir holds more than 700 gallons of water, heated to such an extent as to produce a pressure of 224 lbs. to the square inch. It was claimed for the new engines that they were very economical in every respect. It was pointed out that the engine would be especially useful on the Metropolitan lines, as it neither gave off smoke nor deleterious gases. In a few weeks an engine of this character will be used on the tramway at Leeds and another at Liverpool Docks.

At the concluding General Meeting of the Association it was announced that the Meeting in 1880 will be held at Swansea, the President-Elect being Prof. Ramsay, LL.D., F.R.S.

NOTICES OF BOOKS.

A Manual of the Geology of India. Chiefly compiled from the Observations of the Geological Survey. By H. B. MEDLICOTT and W. T. BLANFORD. Calcutta: Geological Survey Office. London: Trübner and Co.

WE have had, from time to time, the pleasure of drawing the attention of our readers to the important results worked out by the Geological Survey of India. The memoirs and reports of the Survey have become too numerous and bulky for general consultation. Much information on the Geology of India is scattered in various learned journals, both Indian and European. Hence a digest or compendium, showing at least the more important facts observed and the chief conclusions arrived at, has become imperatively requisite, and we are glad to learn that the Government has seen this necessity, and has directed the present Manual to be drawn up.

The first volume is devoted to peninsular India, whilst the second treats of the extra-peninsular portions, such as Sind, the Punjab, the Himalayan and Sub-Himalayan regions, and British Burma. Concerning this extra-peninsular area it is remarked that it is "geologically an intrinsic portion of the Asiatic continent, whilst peninsular India is not."

The authors find ample evidence that India was affected by the cold of the Glacial epoch. The poverty of the living fauna as compared with the fossil fauna of the Siwaliks, as Mr. Wallace happily suggests, is best explained by a secular decrease of temperature. The eleven extinct elephants and mastodons are now represented by a solitary living form. Against fifty known fossil species of ungulates the same area affords only eighteen recent forms. The Tálchir formation displays the same kind of evidence by which the existence of a Glacial epoch is recognised in more northern regions.

As regards the former distribution of land and water, the authors conclude that in Eocene times peninsular India was part of a tract of land, perhaps even of a great continent connected with Africa. To the east and north-east was a sea, where now rise the Assam hills, whilst on the north-west another sea covered great part, if not the whole, of Persia, Baluchistan, the Indus plain, and part of the plain of the Upper Ganges. The recent fauna, they believe, speaks in favour of the connection of Southern India with the Malay Islands and Africa in the early Tertiary times.

The authors do not entirely agree with the system of anima geography propounded by Mr. Wallace. On comparing the mammalian fauna of the Oriental region with those of the three neighbouring regions, they consider that the strongest affinities are with the most distant of the three—the Ethiopian. This, they hold, points to the existence of an older fauna once common to Africa and India, though now partly replaced in either country by newer types. It has been supposed that Ceylon, with the southern portion of the Indian peninsula, may have been united with the Malay countries later than with Africa. As far, however, as the sea-bottom between Ceylon and the Malay Islands is known, there is nothing to prove a recent extension of land in this direction. The affinities of the land-shells of India are rather with the Australian than with the African fauna. As these molluscs are supposed to be of very high antiquity, the resemblance may be due to a communication existing in the Mesozoic times.

The existence of a former continent, Lemuria, stretching from Madagascar to the Malay Islands, and connected at times with Africa, and at times again with Asia, still remains a speculative question. But that the interval between Africa and India was once bridged over, so as to admit of the easy interchange of mammalian species, scarcely admits of doubt.

As regards its soils, the authors state that India may be very roughly divided into the extra-tropical wheat-region; the damper portion of tropical India—the rice, sugar, &c., country; and the drier tropical parts—the so-called black-soil country, suitable for the cultivation of cotton. The wild floræ of these three regions are respectively as distinct as are the cultivated crops.

Pre-historic implements, bearing marks of human or anthropoid industry, have been found in India to a considerable extent. Chipped palæolithic weapons were first found near Madras by Messrs. Foote, King, and Oldham, and have been subsequently met with in Orissa, Bengal, and Assam. Knives made from agate, flint, or chert are possibly of more recent origin than the quartzite implements. Similar flakes are still in use among the natives of the Andamans. Neolithic stone implements—so-called "Celts"—with surfaces smoothed by grinding, have been noticed at Kirwi, Chutia Nagpur, and Kurg. A single bronze axe has been discovered near Jabalpur. Copper weapons are more numerous, but still scarce. Iron implements are abundant, and the authors suggest that the art of working this metal may have been discovered earlier in India than in more western regions. They consider that closer and more extended research in India will doubtless bring to light important evidence on the earlier career of the human species.

The work is illustrated with a judicious assortment of figures of Indian fossils of different epochs, and is further provided with an Appendix in the shape of a very large geological map, which forms a companion volume.

CORRESPONDENCE.

WEATHER-INDICATIONS.

To the Editor of the Monthly Journal of Science.

SIR,—Have any of your meteorological correspondents noticed a fact with which I have often been struck,—that is, that in a season of confirmed character the ordinary weather-indications become of no value? Thus in 1868 I often observed that lowering clouds, a red sunrise, the low flight of swallows, eddies of dust, &c., were not followed by rain. Conversely in the present season, a rising barometer, red sunsets, very lofty flights of swallows, and other indications of fair weather, are succeeded by rain.—I am, &c.,

CLOUD-GAZER.

ANTI-VIVISECTIONIST INCONSISTENCY.

To the Editor of the Monthly Journal of Science.

SIR,—In a recent magazine article a distinguished writer, after describing with great zest a day's trout-fishing which he enjoyed at Cheneys, enters upon the defence of "sport" in general, which he defines as killing for the sake of killing. He ventures on the unwarrantable statement that save "the dogs and the cats which have learnt from him," man is the only animal which indulges in such gratuitous slaughter. Waiving, however, any present discussion on this point, I cannot help remarking that to indulge in and to justify "sport" come with a very bad grace from one who, like the writer in question, is an avowed opponent of vivisection.

If the common infliction of pain and death upon animals for mere amusement, or for the exercise and display of skill, is to be tolerated without rebuke either from law or from public opinion, how can a much rarer infliction of pain for a high and important purpose be branded as a horrible crime?—I am, &c.,

J. W. SLATER.

NOTES.

BIOLOGY.

M. E. Renon predicts a series of bad seasons until 1883, when the summer is to be warm. The winter of 1881-82 will be exceptionally severe. He assumes a period of 41 years, the beginning and end of which are characterised by bad weather. Referring to the fact that in the past July, as in July, 1758 and 1816, the temperature in Western Europe was exceptionally low, though accompanied by south and south-west winds, he supposes that the African current, in place of taking its usual course over Spain, France, &c., has been deflected to the east, thus accounting for the great heats experienced in Italy, Hungary, Bulgaria, &c.

In a paper on the "Production of Electricity by the Rays" M. Ch. Robin states that, as early as 1865, he demonstrated that the electric apparatus in the tail of the Ray acts in the same manner as those of the Torpedo and the Gymnotus, the differences between them being merely of a secondary nature. Quite recently he has verified anew the exactitude of his former observations.

"La Correspondance Scientifique" gives an interesting account of the museum founded at Cette by M. J. B. Doumet, a young French officer who, in 1815, was dismissed from active service on account of his suspected attachment to the Empire. It is exceedingly rich in the mollusks, crustaceans, fishes, and reptiles of the Mediterranean and of the adjacent countries. The collection of exotic Lepidoptera is also very fine. One of the greatest curiosities is the original herbarium of Michel Adanson, the celebrated botanist, the maternal grandfather of Doumet.

P. H. Reinsch has observed the occurrence of the mycelia of fungi in a hen's egg ("Botanische Zeitung," 1879, No. 3, pp. 37, 38).

M. A. Chaveau, in the course of experiments described in the "Comptes Rendus," observes that certain Algerian sheep were perfectly proof against the poison of carbuncle, even on repeated inoculation—a fact which raises a number of most important questions.

Professor K. Th. Liebe, in the "Transactions of the Imperial Academy of Sciences of Vienna," contends that during the second diluvial period the hills of southern Bohemia and Moravia were the starting-point from which the virgin forests invaded the great diluvial steppe of Central Europe to the north of the Alpine chain.

M. B. Schnetzler communicates to the Academy of Sciences certain observations on *Arum crinitum* and its relations to insects. Its carrion-like odour entices numbers of flies, such as *Musca Cæsar*, which lay their eggs at the bottom of the spathe where the resulting larvæ necessarily perish. Common flies and even Acarides are often found imprisoned among the hairs. Some flies, however, less eager to lay their eggs, are attracted by the glandulous hairs upon the spadix, which lead them, like the steps of a ladder, to the stamens. There, on alighting upon the anthers, they cause the pollen to be emitted, and fly away to deposit their eggs in another spathe, at the bottom of which they deposit upon the stigmata the pollen brought from the former flower. The dead flies, though upon a moist surface, appear dried up. It appears that the hairs which overspread the inner surface of the spathe secrete an acid which, like that exuding from the hairs of *Drosera*, contributes to the transformation of the nitrogenised parts of the insects into matter absorbable by the spathe. Hence the author, without denying that insects contribute to the fecundation of this flower, contends that they contribute to its nutriment, and holds that it was rightly named *Arum muscivorum* by the younger Linnæus.

According to Ernesto da Canto, the smoke of burning straw or brush-wood has been found very beneficial to a variety of plants, but especially to the pine-apple. The observations were made in the hot-houses used in the Azores for forwarding pine-apples in the cold season.

In the "Rivista Orticale" hemp-plants are recommended to be cultivated in vineyards, orchards, &c., for the banishment or destruction of noxious insects. The absence of insects in hemp-fields is said to be a well-known fact.

Worms have been observed in fresh hens' eggs at New York. The species was not determined, but it may probably be *Distoma ovatum*, which lives parasitically in the cloaca of poultry.

In a paper communicated to the Academy of Sciences M. Richet shows that muscles in a state of contraction are more excitable than when in a state of repose. The relaxation of a muscle is not abrupt, but gradual, and the true form of the muscular shock is masked by the weights which extend the muscle. For muscles extended by a weight there is a period of *latent contraction*, during which the muscle is most excitable.

M. Poincaré has ascertained that guinea-pigs are affected by the vapour of nitrobenzol much more seriously than is man. Workmen exposed to these fumes in the manufacture of aniline rarely experience more than a transient loss of consciousness, which is at once removed on exposure to the fresh air. All the guinea-pigs experimented upon perished. On examination the liver, kidneys, nervous centres, and lungs were all found strongly congested. The chief symptom observed during life was a difficulty of breathing.

M. Léon Fournol, in the "Journal d'Hygiène," gives an interesting summary of our present knowledge concerning poisonous fishes, which appear to be a source of grave danger. We may trace here four distinct cases. There are fishes perfectly harmless at some seasons of the year, but poisonous at others. This has been observed in Japan with the common salmon, the bonito, and the albicore. The symptoms generally resemble those caused by the ingestion of corrupted meat, and though alarming are rarely fatal. Other fishes, such as *Lethrinus nambo*, are wholesome when young, but become poisonous when they reach a certain growth. Other aquatic animals—the conger, the pike, the barbel, the prawn, and the mussel—are occasionally and capriciously poisonous. In one instance a number of persons who had partaken of the spawn of a large barbel experienced very severe symptoms of poisoning, whilst one of the party who had not eaten any of the spawn escaped. The liver and the head in several species of fish inhabiting different parts of the world are found exceptionally dangerous. The occasionally poisonous action of mussels, oysters, &c., is ascribed by eminent authorities to their having eaten the eggs of the star-fish, which are occasionally found in these mollusks on dissection, and which, when handled, produce violent cutaneous irritation. Other fishes appear to be poisonous at all times and under all circumstances. Prudence dictates that the roe, liver, &c., of all unknown fishes should be carefully avoided, and it is very doubtful whether aquatic species of animals too small to admit of the removal of the alimentary canal, with its possible contents, should be eaten at all. The entire question offers a splendid field for research, both biological and chemical.

M. J. Künckel has published in the "Comptes Rendus" the results of an extended series of researches on the nervous system of the Diptera. He recognises in some cases an absolute centralisation, or an extreme dispersion of the nervous centres, with the most varied intermediate arrangements, but each family has its nervous system constructed upon a peculiar and invariable plan. The number of nervous centres varies, however, gradually from one family to another.

M. E. Brandt has laid before the Academy of Sciences certain interesting results concerning the nervous system of insects. He finds that in the genera Rhizotrogus, Stylops, and Hydrometra the subœsophagian ganglion is not separated from the following ganglia, as has been supposed to be the case in all insects. Hence this character can no longer serve to distinguish the nervous system of insects from that of the other Arthropoda. The pedunculated bodies of Dujardin, or the cerebral circumvolutions, are not only met with in some insects, but in all. In some insects a difference in the development of these convolutions is found, even among different individuals of the same species. Wagner's assertion, however, that in the male bee these convolutions are entirely wanting, is inexact. They are present in all male insects, though in the social species in a much lower degree. The development of that portion of the brain named the hemispheres is proportional to the grade of intelligence, though that of the entire brain is not. In the Lepidoptera, Coleoptera, Hymenoptera, and Neuroptera the first thoracic ganglion is simple, and the second compound. In others (such as several dipterous genera), both the first and second thoracic ganglia are compound.

According to M. Arloing, the formiate of soda lowers the temperature of the animal system. It neither affects the heart nor the kidneys as profoundly as does the salicylate.

MM. Brissaud and Richet, writing in the "Comptes Rendus," point out that there is a very intimate connection between the normal muscular tone, catalepsy, cramp, myo-reflex contraction, and the contraction of hemiplegia, and that forms of transition between these states will, doubtless, be traced.

From experiments upon *Scyllium canicula*, M. Cadiat concludes that digitalin, given in a toxic dose, is a heart-poison, acting directly upon that organ and producing a tetanisation of the ventricle and a diastole of the auricle. It has no action upon the nervous centres, the peripheric nerves, or the muscles.

According to M. de Brévans, flights of swallows are sometimes seen going northwards as late as October, returning again to the south when leaving Europe. The author—as quoted in "Les Mondes"—remarks that this year the swallows have returned later than usual. This does not agree with observations made in England.

M. E. Heckel has observed a well-marked case of trichinosis in a young hippopotamus which died in the Zoological Gardens at Marseilles. He asks if the pachydermata are especially liable to a spontaneous development of this terrible parasite?

M. Dareste, having placed eggs in warm water of a temperature proper for incubation, found that all of them presented marks of incipient development, though in every case the embryo had perished. In one case only the structure had escaped decomposition, and it was a monstrosity of the class which the author has described as omphalocephalous. The heart, clearly distinguishable, was placed above the head.

Dr. A. W. Lyte, in the "Medical Brief," recommends the oil of sassafras as an effectual antidote for the bite of the copperhead snake, and as destructive to all insect life.

The application of osmic acid to microscopical purposes forms the subject of a paper read before the Royal Microscopical Society on the 12th of March by T. J. Parker, B.Sc. It is valuable principally on account of its property of killing and hardening protoplasmic structures with the minimum of shrinkage, and also staining fat of an intense black colour. The former property renders it of great value in embryology and in the study of infusoriæ and delicate animal tissues: the latter gives it its pre-eminence in bringing out the ramifications of the finer medullated nerves, and the structure of the adipose tissue. Some recently-hatched glass-crab (Phyllosoma) were immersed for ten minutes in a 1 per cent solution of osmic acid, and subsequently treated with alcohol of gradually-increasing strength, commencing with 50 per cent, and ending with absolute. The central nervous mass was stained jet black; the muscles, glands, &c., assumed a greyish brown, the striæ of the muscular fibres becoming remarkably distinct. It has been used with great success for the preparation of delicate vegetable tissues; the manipulation is similar, after staining and treatment with alcohol; soaking in oil of cloves follows; the sections are cut by imbedding in cocoa butter, and mounted in balsam. A mixture of osmic and chromic acids (chromic acid, 0·25 per cent, 9 parts; osmic acid, 1 per cent, 1 part) answers, in some respects, better even than osmic alone for vegetable preparations.

In the same journal (vol. II. p. 354) is a paper by George Hoggan, M.B., and Frances Elizabeth Hoggan, M.D., "On the Development and Retrogression of the Fat Cell." The mode of preparation of the specimens is minutely described, and the manipulation and effect of the various staining and other reagents given in detail.

The employment of osmic acid and other stains is opening a new field for the histologist. The following process is used by Dr. Richard Altmann, of Giessen, for the investigation of certain animal tissues under the microscope:—The tissue is either impregnated by soaking, or else its vessels are injected with olive or castor oil, and then placed in osmic acid until the oil is hardened and blackened; finally it is transferred to a solution of potassium or sodium hypochlorite ("Eau de Javelle"), which completely destroys the tissue, the fatty material being left, and retaining the form of the vessels or spaces into which it was injected. The solution of osmic acid is of 1 per cent strength. The process has been successfully employed for the investigation of medullated nerve, striped muscle, epithelium, cornea, choroid, and retina. Full details will be found in the "Archiv fur Mikroskopishe Anatomie." vol. xvi. (1879), p. 471; a translation in the "Journal of the Royal Microscopical Society" for August. The Royal Microscopical Society are doing good service by the carefully-selected translations of foreign papers on biological subjects.

CHEMISTRY AND TECHNOLOGY.

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CHEMISTRY AND TECHNOLOGY.

It would seem that restrictions upon the Chemical Arts, to whatever length they may be carried, must fail to prevent the injuries to which farmers and landowners complain, for in a paper published in "Die Chemische Industrie" on the "Injury to Vegetation by Acid Gases," Herr R. Hasenclever admits that many causes, in addition to the fumes of chemical works, have had a deleterious action upon trees. He points out that the use of coal as fuel, whether in private houses or in mechanical manufactures, &c., has exerted a very devastating action upon vegetation. The memoir is accompanied by a coloured engraving of the leaves of various trees as affected by acid vapours. German observations confirm the view entertained in this country, that the plane-tree is distinguished by its power of resisting acids.

An exhaustive research on the action of ozone upon the colouring matters of plants has been conducted by Prof. A. R. Leeds. The colouring matters of both leaves and flowers of the species experimented upon were partly or wholly destroyed by ozone; but Prof. Leeds found that a considerable percentage of ozone is required to produce this result, or if such small amounts as are obtained in the customary methods of ozonising air by phosphorus are employed (1 to 3 m.grms. per litre), a large volume of ozonised air must be used, and a considerable interval elapse, before bleaching is effected.

The *Palmella cruenta* is a small alga much resembling clotted blood. Its colouring matter, *palmellin*, Dr. T. L. Phipson finds to closely resemble hæmoglobin. It is, like the latter, insoluble in alcohol, ether, benzol, sulphide of carbon, &c., but it dissolves in water. It is, further, dichroic; it is composed of red matter united to an albuminoid substance, and is coagulated by alcohol, acetic acid, and by the application of heat. Like the colouring matter of blood, it produces absorption-bands in the yellow part of the spectrum, though not exactly in the same position. Palmellin easily enters into putrefaction, giving off a strong ammoniacal odour, and, to complete its analogies with the colouring matter of blood, it contains iron.

M. Lami has investigated the comparative influence of milking twice or thrice daily. He considers the latter system, other conditions being the same, more favourable to the production of butter.

A correspondent of the "Chemical News" calls attention to the fact that during the past two years no less than eleven claimants for recognition as elementary substances have presented themselves in that journal, their names being Davyum, Neptunium, Lavoesium, Mosandrum, "New Earths," Philippium, Ytterbium, Decipium, Scandium, Norwegium, Uralium. While several names in this formidable list are, doubtless, destined to stand the test of time, the majority, it is thought, will have to join the noble army of "defunct elements." Probably only the "fittest" will survive. And the question is, what delay shall occur before mentioning these substances in the instruction of advanced classes? What authority is weighty enough to settle the existence or non-existence of these bodies?

At a meeting of the Academy of Sciences, on September 1st, M. P. T. Cleve announced the discovery of two new elements in erbia, which he has named respectively *Thullium* and *Holmium*.

Herr Fleitmann conceived the idea that the brittleness of nickel and cobalt was due to absorption of carbonic oxide. He succeeded in removing it by the addition of small quantities of magnesium, obtaining both metals in a perfectly malleable and ductile condition. To prevent explosions, the magnesium is introduced through a hole in the lid of the crucible after the oxygen has been removed by the addition of fragments of charcoal.

A new method for the detection of arsenic has been devised by Prof. Selmi. The method is that of Schneider modified so as to incur no losses. The substance to be examined is treated with hot concentrated sulphuric acid, and during the same time is traversed by a current of hydrochloric acid gas, which carries with it all the arsenic in a state of chloride, separating it from the organic substances with which it was mixed. The arsenical liquid is then placed in a Marsh's apparatus and tested in the usual manner. Prof. Selmi has been thus able to obtain the metallic ring on operating upon 100 gms. of animal matter containing 1-400th of a milligrm. of arsenious anhydride.

Reichenbach's wood-tar colour Pittical has been resuscitated by A. Gratzel, and it is now an article of commerce at the price of £4 per kilo., under the name of "German-Imperial-Flower-Blue," with reference probably to the blue corn-flower, which is said to be the favourite cognizance of the German Emperor. The acetate is generally used for dyeing, dissolved in a little acetic acid diluted with water, and almost neutralised with ammonia. In this bath silk and wool take a fine reddish blue without the aid of any mordant. Cotton and other vegetable fibres are prepared with a solution of tannin, followed by a solution of tartar emetic. The colours produced are perfectly fast. From Reimann's "Farber Zeitung" we learn that if Pittical is separated from its alkaline salts, and heated with alcoholic ammonia in a sealed tube to 176°, a base is obtained closely resembling rosanilin in its composition. It dissolves in acetic acid with a corn-flower blue colour. The new colour is the first member of a new series of tinctorial products, which may prove of great importance.

Dr. Meusel, of Breslau, prepares colouring matter by treating coal-dust with nitric acid, or with a mixture of alkaline nitrates and sulphuric acid, or with other oxidising agents. A part of the coal is thus rendered soluble with a deep brown colour in alkaline hydrates or carbonates. The black residue serves as a body colour. The brown alkaline solution can (says the "Die Allg. Polyt. Zeitung") either be used at once, or metallic salts of a black or dark brown colour may be precipitated from it, or the precipitate produced by the addition of acids may be used as a pigment.

According to the "Moniteur des Produits Chimiques," ostrich feathers are bleached in a bath of 10 grms. barium peroxide to 1 litre water, heated to 30°. In this they remain for forty-eight hours, and are then washed, treated with weak hydrochloric acid, and dried.

According to M. Moyret, 40,000 kilos. of copperas, pyrolignite of iron, and other iron mordants are used daily in the Lyon district for weighting black silks. For whites and bright shades sugar is used, to which the author proposes an addition of a decoction of quassia. Silk dresses thus prepared would serve for fly-papers! Stannic chloride, mysteriously spoken of in the trade as X, is employed in addition to sugar. Barium sulphate has also been proposed, but it deprives the silk of its lustre.

The following formula for preparing a mordant from lees of wine is taken from a recent number of "Chemiker Zeitung":—Fresh green lees, with the addition of two-fifths sodium tartrate, are evaporated down to one-sixth the original volume. 15 grms. of Cologne glue and 10 grms. tannic acid are added. The mass is pressed, rubbed over with alcohol and tannic acid, dried in the air, and powdered. For use it is to be further mixed with one-fifth per cent sodium tartrate. It is recommended for dying full shades in wool and silk, and is said to render the aniline colours permanent. In dying woollen cloth a decoction of Saponaria root is added both to the mordant and the dye-bath.

In a communication on the action of vinegar upon alloys of lead and tin Herr R. Weber shows that vinegar attacks pure tin as well as alloys with lead, the quantity of metal dissolved increasing with the proportion of lead present. Alloys of tin and lead, to which 4 per cent antimony had been added, were also attacked, and lead entered into solution.

Nickelising without electricity may be effected, says the "Moniteur Industriel," by introducing into a 5 or 10 per cent solution of zinc chloride as much of a salt of nickel as is sufficient to give it the ordinary colour of a nickel-bath. The articles to be coated, previously well cleaned, are laid in this solution, and the process is complete in from half an hour to an hour. Cobalt can be deposited in the same manner.

T. Troost has reported to the Société d'Encouragement pour l'Industrie Nationale on M. Gaiffe's Galvanic Deposits of cobalt. The metal is deposited from a solution of the double sulphate of cobalt and ammonia, and is superior to nickel at once in hardness, tenacity, and in beauty of colour. It is much less oxidisable than iron, but is very easily dissolved by acids.

From a report by M. Aimé Girard on M. Kuhlmann's (junior) methods of conveying acids, we learn that M. Kuhlmann, in place of carboys, employs floating reservoirs in the form of an ordinary boat, fitted with air-chambers to give them sufficient buoyancy. For sulphuric acid of 60° B. and upwards these are constructed of sheet-iron, and have been in successful use for some years on the canals of the North. For hydrochloric acid he uses cylinders of hardened india-rubber, kept in their form by an external framework of wood. A modification of the structure serves for transport by rail.

The value of aluminium sulphate as a disinfecting agent is ascribed by A. Tedesco in "Die Chemische Industrie" to the following action:—The ammoniacal products of decomposition are fixed as ammonium sulphate; the liberated aluminium hydrate carries down all suspended particles, forming with them a solid precipitate. The organic cell, in contact with aluminous compounds, absorbs alumina with great avidity, losing thereby its vegetative power, and putting an end to the process of decomposition. Herr Tedesco considers bauxite and wochenite the best materials for the preparation of a sanitary sulphate of alumina. Kaolins are readily attacked by sulphuric acid, but are poor in alumina and comparatively costly.

The influence of the chemical composition of water in the preparation of raw silk is pointed out in a communication from the Instituto Technico Superiore of Milan. In silk are distinguished the soluble constituents, "varnish," or "gum" and colouring matters, and, on the other hand, the insoluble fibre. The soluble constituents give raw silk its brightness, colour, and strength, and should therefore be preserved as far as possible. For the purpose of unwinding the cocoons the natural gum should be softened, but not dissolved. According to Franceson, silk, if deprived of all its soluble constituents, loses at the same time its strength and elasticity. The authors of this paper find that though the loss of strength is proportional to the loss of soluble matter, the elasticity is but slightly diminished. In order to minimise the loss sustained in softening the cocoons hard waters are used, and soft waters are artificially modified by the addition of sulphate of lime and carbonate of soda. Silks which are to be dyed bright colours, however, should be spun out of soft water.

An improved device for testing petroleum oils, brought out by Mr. Holly, is described by "The Engineering and Mining Journal." With the common oil-tester it is extremely difficult, even for one skilled by long practice, to get reliable results except by taking the mean of a number of tests, since the approach of a jet of flame, however small, to the surface of the oil, as usually practised, destroys the accuracy of the test more or less, either by the local heating of the oil or by the production of disturbing air-currents. Mr. Holly modifies the apparatus usually employed by arranging the poles of a battery within three-eighths of an inch from the surface of the oil, so that he is able to pass a spark between them, as the thermometer registers an increase of one degree in temperature. By this means the disturbing influences above noted are reduced to a minimum, and much greater accuracy in the results of such examinations is assured.

The Patents-Committee of the German Association for Promoting the Interests of Chemical Industry recently held a session at which an interesting communication from the scientific staff of the Baden Aniline Works was read. The authors point out that neither a novel substance nor a novel application of a substance obtained chemically can be patented in Germany. Concerning the preliminary investigation they doubt the possibility of deciding *à priori* on an invention.

GEOLOGY, PALÆONTOLOGY, &C.

The Memoirs of the Geological Survey, England and Wales, includes one on "The Geology of the N.W. part of Essex and the N.E. part of Herts, with parts of Cambridgeshire and Suffolk, by W. Whitaker, W. H. Penning, W. H. Dalton, and F. J. Bennett. The authors describe the cretaceous strata from the Gault to the Upper Chalk, the Eocene beds from the Thanet Sands to the London Clay, the Red Crag and the Glacial deposits of boulder-clay and gravel and sands. We notice that in a bed of so-called peat found in a cutting between Audley End and Saffron, in the valley of the Cam, two cart loads of large mammalian bones were taken from an area of 60 feet by 20. Some of them are the lower jaws of an ox, probably *Bos longifrons.* They bear artificially-made markings, and along with them was found a very fine horn of the Irisk elk, *Cervus Megaceros.*

The "Records of the Geological Survey of India" contain a translation of a paper on the geographical distribution of fossil organisms in India, read before the Imperial Academy of Sciences in Vienna by Dr. Waagen, formerly of the Geological Survey of India. The author considers that at the close of the Eocene epoch the sea retreated altogether from India; only in the neighbourhood of Karrachi and Arracan does it appear to have touched the Indian continent, so that the sea of the Miocene and Pliocene periods probably extended away to the southward, whilst a north-westerly connection of the continents probably took place with North Africa through Arabia. Blanford's supposition of an Indo-Oceanic continent uniting Africa, India, and Australia, and existing without important changes from the end of the palæozoic up to the miocene and pliocene periods, is thoroughly erroneous. A submerged forest has been discovered on Bombay Island, remarkable as showing that in recent or sub-recent times a depression must have taken place in the immediate neighbourhood of ground which appears to have been raised.

Another number of these valuable "Records" contains an interesting discussion on the origin and affinities of a fossil jaw, found in the Sivalik range, which is referred to a new species, *Palæopithecus sivalensis*. It was intermediate in size between the mias and the gorilla, but in dentition falls between the chimpanzee and man. The author considers that its occurrence is another piece of evidence in favour of the hypothetical sunken continent Lemuria, from which the anthropoids have been dispersed. He suggests that the unexplored tertiaries of Africa, Sumatra, Borneo, and Southern India may probably contain forms bridging the chasm between the highest-known apes and man. In the same district proof has been obtained of the former existence in India of an emeu double the size of the existing emeu of Australia. *Megaloscelornis sivalensis* was a wader probably allied to the adjutant crane, but in stoutness and length of limb approaching the ostrich. Colonel C. A. MacMahon contributes some interesting notes on the supposed glaciation of India. He finds the contour of the hills and valleys in the interior Himalayas sharp and angular, rounded outlines, where seen, being sufficiently explained by the action of sub-aërial forces on comparatively soft and friable rocks. The idea of an ice-cap is thus set aside, and there seems even no evidence that the existing glaciers had ever, within a reasonable geological period, extended lower than 11,000 feet above the sea-level. Mr. Lydekker, in his investigations in the valley of Kashmir, finds no evidence in favour of a former glaciation of the outer hills and the Upper Punjab.

From a memoir on the "Geology of the Salt-Range in the Punjab," by Mr. A. B. Wynne, we learn that the rocks of the salt-range comprise alternations of calcareous, earthy, and sandy deposits, which may be arranged under thirteen main divisions. Nine of these can be referred to as many of the main formations recognised by geologists, whilst the ages of the other four are not satisfactorily determined. The economic resources of the district have been exaggerated. The deposits of salt, indeed, are enormous, and the average annual receipts from their working reach the sum of £388,144. Still we must remember that the world's available supplies of this mineral are incalculably in excess of any conceivable demand for ages to come. In the so-called Mayo mine a pink-coloured salt has been found containing 51 per cent. of potassium chloride, but unfortunately it formed merely a local lenticular deposit, and Mr. Wynne has not been able to detect it in other parts of the range. The coal found in the region is pyritic, shaly, and not very abundant. Sulphur occurs in exceedingly small quantities. Petroleum wells are not copious, a gallon daily being considered a good flow. Sandstones, saturated with oil, are abundant, and might, doubtless, be profitably distilled. The stream-gold yields a scanty return, 4 annas' worth being the average per man for a day's washing.

Copper occurs as a mineralogical curiosity only. Galena is found in small disseminated crystals in the dolomite of Karangli. Iron ores of a first-rate kind are mentioned by Mr. Powell and Dr. Henderson as having been obtained from the Korana hills, but the cost of production would not be remunerative owing to the scarcity of fuel.

The Daltonganj and Aurunga coal fields may, according to the estimate of Mr. V. Ball, F.G.S., yield 30 million tons of coal of a good quality. In this estimate the Singra seams are not included, though it is remarked that they might be profitably worked for some years as open quarries. Concerning the Hutar fields, the author considers that any estimate would be premature, as the lateral extension of the seams is quite unknown. Concerning the Tatapani coal-field nothing definite appears to be known. Iron ores of different kinds, magnetite, carbonate, and carbonate altered into hæmatite appear to be found in considerable quantity, but under circumstances which make their utilisation a somewhat problematical question. The limestone of the region is, however, well adapted for use as a flux. Galena and copper ores occur, but, it would seem, not in quantity.

A recent issue of the "Geological Survey of Canada" contains a paper "On the Fossils of the Cretaceous Rocks of Vancouver and adjacent Islands in the Strait of Georgia," by J. F. Whiteaves, F.G.S. The palæontological researches of the author support the conclusion of Mr. Gabb, based upon an investigation of the cretaceous fauna of California, that a continuous land-barrier between the oceans of that period can scarcely be admitted. The respective faunæ of the Upper Cretaceous of Vancouver and of Texas are even more closely related than those of the same period in California and Texas.

The American Association for the Advancement of Science held its twenty-eighth meeting at Saratoga Springs, N.Y., beginning August 27th, 1879. The meeting was a memorable one, both on account of the large attendance and the great value of the papers presented. The Association was honoured by the presence of an unusually large number of its ex-Presidents, no less than nine being on the platform at one time. The presiding officer, Prof. George F. Barker, M.D., of the University of Pennsylvania, was very happy in conducting the business of the Society, his genial humour in no wise detracting from the dignity of the occasion, and serving as a pleasant refreshment. The other officers of the Association were as follows :—Vice-President of the Physical Section, Prof. S. P. Langley, of Alleghany, Pa.; Vice-President of the Natural History Section, Major J. W. Powell, of Washington, D.C.; Permanent Secretary, Prof. F. W. Putnam, of Cambridge, Mass. In the absence of Dr. George Little, of Atlanta, Ga., Dr. H. Carrington Bolton, of Hartford, who was General Secretary at the St. Louis Meeting (1878), was continued in office. The Chairman of the Sub-section of Chemistry, Dr. Ira Remsen, of Baltimore, was, unfortunately, prevented from attending, and Prof. F. W. Clarke, of Cincinnati, took the position. One of the features of these meetings is the address of the Retiring President. On this occasion Prof. O. C. Marsh, of New Haven, had the duty to perform. His subject was "The History and Methods of Palæontological Discovery." Vice-President Langley gave an address on "Solar Physics," a subject to which he himself has materially contributed. And Major J. W. Powell gave an address on "Mythologic Philosophy, having special reference to the mythologies of the Indian tribes. Dr. Ira Remsen's address was a plea for the study of Organic Chemistry, a branch which he claims is too often neglected in the courses prescribed in colleges and scientific schools. These addresses will appear in full in the annual volume of Proceedings. Heartily welcomed by the meeting was the distinguished astronomer, Dr. Otto Struve, Director of the Pulkowa Observatory, Russia, who is in America for the purpose of securing a larger object lens for a refracting telescope than has yet been made in the world. The lens is to be made by Alvan Clark and Son, of Cambridge, Mass. The lion of the gathering was, undoubtedly, Dr. Thomas A. Edison, of Menlo Park, N.J. He exhibited on Saturday evening, to a delighted audience of 1500 persons, his recently-invented Electro-Chemical Telephone. Speech, music, &c., was transmitted from a distant room, and the sounds issuing from the telephone were heard by every individual in the hall. Perhaps the most remarkable discovery announced is one by Dr. Edison, which will necessitate an entire revision of the physical constants of all known metals. His paper was entitled, "The Phenomena of Heating Metals in Vacuo by means of an Electric Current," and demonstrated that platinum heated *in vacuo* by electricity becomes denser, harder, more infusible, and less liable to disintegration when heated in a flame. Iron treated in a similar manner becomes as hard as steel and just as elastic. Aluminium melts only at a white heat.

The Meeting of the French Association for the Advancement of Science for 1879 was held, in August, at Montpellier, under the presidency of M. Bardoux, the late Minister for Public Instruction. The speaker chose for his subject "Education," viewed chiefly from a literary and a moral point of view. Still he declared that "henceforth the memory must no longer be made the basis of education." He denounced the too great importance attached to words, and quoted Montaigne to the effect that the pupils of many pedagogues were simply "asses loaded with books." The financial statement showed that the capital of the Society amounts to about 300,000 fr. The grants for research last year amounted to 10,000 fr. One of the lectures was given by M. Denayrouze, on "The Progress of Electricity."

M. Barral, Perpetual Secretary of the National Society of Agricure, also delivered a lecture on "The Use of the Rhone Water for Irrigation." The meeting for 1880 will take place in Rheims, in the month of August, while it has been decided to hold the meeting of 1881 at Algiers, during the month of April. For this meeting M. Chauveaux, Director of the Veterinary School of Lyons, has been elected the President. Among the papers read before the Chemical and Physical Sections were: "On the Compound Ammonias," by M. Buisine; "On the Oxidising Action of Cupric Oxide," by M. Cazeneuve; "On the Determination of Methylic Alcohol in Ethylic Alcohol," by M. Caillol; "On the Calcareous Soils of Barcelona, from a Chemical Point of View," by M. Luis Cabello e Ibanez; "On the Emissive and Absorbent Powers of Flames, by M. Rosetti; "On a Compass for the Measurement of Powerful Currents," by M. Ducrétet; "On the Method of Measuring the Intensities of the Currents of Bunsen Batteries by means of Thomson's Galvanometer," by M. Mercadier; and "On Thermometric Measurements of High Temperatures," by M. Crova.

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PHILOSOPHICAL SOCIETY

I. LEGENDS OF SEPULCHRAL AND PERPETUAL LAMPS.

By Prof. H. Carrington Bolton.

EVERY science and every art appears to have had, at some period in its history, aims and aspirations of an unphilosophical and superstitious character; every branch of learning has had its infatuated enthusiasts working at unachievable projects and striving to reach unattainable goals. In astronomy, clever and learned men endeavoured to foretell the fate of mankind by a study of the stars; in mechanics they sought for perpetual motion: in mathematics, for the quadrature of the circle; in medical art for a universal panacea and an elixir of life; and chemical science was for many centuries a fertile field for speculations no less chimerical and unsubstantial.

The extraordinary delusions of the alchemists have been summarised by Wiegleb, a German chemist of the last century, in the following words:—"At one time they turned their attention to the production of pearls and precious stones; at another to the fixation of ordinary mercury, and hence to its extraction from natural metals; some sought to transform water into vinegar, others eneavoured to make glass flexible and malleable. They sought also to prepare for the physician the much-needed elixir of life, to transform common salt into saltpetre, to prepare a universal solvent, *to discover the means of causing lamps to burn perpetually*, to reproduce plants and animals from their ashes, and even to effect the resurrection of the dead! Besides these chimerical pursuits, the favourite and most enticing of all was the transmutation of the common or base metals into silver and gold." *

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* Wiegleb, Hist. Krit. Untersuch. d. Alchemie. Weimar, 1777. 12mo,

The belief in ever-burning lamps mentioned by Wiegleb is not unfrequently alluded to in prose and poetry, yet detailed and exact information on this point is to be had only by patient research. Many volumes have been written on the history of chemistry, and on alchemy, narrating the fanciful views and arduous labours of the would-be transmuters of the base metals, but they seldom make reference to the sepulchral and perpetual lamps.

During the sixteenth and seventeenth centuries a belief in the actual existence of ever-burning lamps seems to have been very real and widely prevailing. Many learned writers maintained that the ancients were acquainted with the preparation of a combustible fluid, which, while burning and giving out light, diminished not in quantity and potency. Lamps supplied with this marvellous liquid were placed in tombs by the ancient Romans, and continued burning until some ruthless explorer desecrated the subterranean places of burial and allowed air to enter, whereupon the flame flickered and shortly expired. These astonishing lamps "burned the most brightly where there was most want of air, and were always extinguished by the immission of external air."—(Dr. Plot.)

To discover the secret of preparing this combustible yet inconsumable liquid was one of the alchemist's dreams; in their figurative language they endeavoured to "concentrate the four elements, and to make therefrom a wonder-working essence."—(Kriegsmann.) The material upon which their operations were conducted, and in which they placed great reliance, was fine gold; this, they said, resolved by hermetic methods into a "clear liquid," supplied, by its "incombustible oiliness," the perpetual light. Some authors describe the liquid in question as an "extract of the elements prepared with great labour, and possessing the property, when provided with a suitable ferment of silver or gold, of forming the white or red tincture capable of transmuting the base metals." But without the ferment it nourished the ever-burning lamps, and on account of its exceeding costliness was consecrated to the mythological divinity Pluto." Such is the description of this liquid contained in a rare and quaint little 16mo., entitled "Taaut," written by one Wilhelm Christoph Kriegsmann, and published at Frankfurt in 1665 (page 65 of Notes).

The alchemists did not, however, always employ such enigmatical and obscure language when writing of this mysterious liquid. Trithemius—a learned abbot of the fifteenth century, who found leisure amid his Benedictine duties to write works on theology, history, philosophy, and alchemy—gives two receipts for making the inexhaustible oil: one of these reads as follows:—

"Mix four ounces of sulphur and four ounces of alum, sublime them, and convert them into flowers. Take two and one-half ounces of these flowers, with half an ounce of borax and Venetian crystal, and pulverise the whole in a glass mortar. Put the powder into a phial, and, having poured into it spirit of wine four times rectified, cause it to digest. Pour off the spirit of wine, and, having added some new, repeat the operation three or four times, until the sulphur runs on hot plates of brass without smoke, like wax. You must then prepare a proper wick, which may be done in the following manner: take filaments of mineral flax of the length of the finger, form them into a packet half as thick as the finger, and tie them with a white silk thread. The wick being thus arranged, cover it with the sulphur prepared as before described, and immerse it in the sulphur in a vessel of Venetian glass. Place the whole upon a sand-bath for twenty-four hours, so that you may always see the sulphur boil, and the wick being by these means well penetrated and impregnated with that aliment, put it into a small glass with a wide mouth. Then fill this vessel with the prepared sulphur and place it in warm sand, that the sulphur may melt and surround the wick. If it be then kindled it will burn with a perpetual flame."*

It is hardly necessary to add that the process, described with so much care, would prove very unsatisfactory to any curious investigator.

The alchemists also claimed that an inconsumable oil could be obtained by treating gold with oil of vitriol, and they called the product *oleum vitrioli aurificatum*. Other receipts are given by the Jesuit Athanasius Kircher, and will be found by the curious in his "Mundus Subterraneus." †

The belief in perpetual lamps was sustained and diffused by the publication of many legends, which appear to have been freely accepted by a credulous people, notwithstanding their highly improbable character and the slender basis of truth on which they were founded. One of the most famous and oft-quoted legends establishing this superstitious belief was that of the tomb of Tulliola. In the pontificate of Paul III. (1534—1549), the same who convoked the Council of Trent, a tomb was opened, at Rome, which contained the body of a young woman in a remarkable state of preservation. Her flesh was uncorrupted,[*] and her tresses were still bound with a small plate of gold curiously chased and enamelled. A burning lamp hanging in the vault was extinguished as soon as the air entered. On the walls was carved the inscription "*Tulliola filiæ meæ*," which was thought to refer to Tulliola, the daughter of Cicero, whose death he laments in his letters to Servius Sulpicius.[†] One authority states that the lamp burned several hours after opening the tomb, though it must have been closed more than fifteen hundred years. This legend was the subject of much comment. Montfaucon,[‡] the eminent French antiquary and philologist, repudiates the story, and maintains that it is merely the revival of an older tale concerning the discovery of an uncorrupted body, in March, 1485, related by Etienne de Infestura and Alexander ab Alexandro. The latter describes the marvellously perfect preservation of the remains, and adds—"To see the body one would have have thought it interred but a short time; there was no inscription, though Pomponius thought it to be the body of Tulliola, daughter of Cicero, or that of Priscilla, wife of Abascantius."

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* TRITHEMIUS, Tractatus de Lapide Philosophorum. 1611, 8vo.

† Vol. ii., Lib. 8, Sect. 3, De Asbesto, &c.

Another legend, which supplied partisans with one of their strongest arguments, was that of the Lamp of Olybius. In the year 1500 some peasants, digging the earth to a considerable depth, near Padua, discovered a tomb containing lighted lamps, one of silver and the other of gold; or, according to another authority, there was but one lamp, placed in an urn between two phials, one filled with liquid gold and the other with liquid silver, by virtue of which the light had been maintained since the days of the Romans. According to inscriptions[§] on the urns the lamp had been prepared with great labour by Maximus Olybius. Representations of the two vases, with their inscriptions, are given in Kriegsmann's "Taaut," and in several less rare works.[‖] Licetus, of whom more hereafter, gives a letter of Maturantius, who tells his friend Alphenus that "Both the urns and the lamps and the phials have fallen into my hands, and are now in my possession. If you saw them you would be astonished. I would not part with them for one thousand crowns of gold." Two similar sepulchral lamps are to be seen in the Museum of Rarities at Leyden.

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[*] Perhaps converted into adipocere (?).

[†] Ad Familiares, iv., 6.

[‡] L'Antiquité Expliquée. Paris, 1719.

[§] *On the smaller urn:*—Abite hinc pessimi fures! Vos quid voltis vestris cum occulis emissitiis? Abite hinc vestro cum Mercurio petasato caduceatoque. Maximus maximo donum Plutoni, hoc sacrum facit.

On the larger urn;—

"Plutoni sacrum munus ne attingite fures!
  Ignotum est vobis hoc quod in urna latet;
Namque elementa gravi clausit digesta labore
  Vase sub hoc Modico Maximus Olybius.
Adsit fœcundo custos sibi copia cornu,
  Ne pretium tanti depereat laticis.

[‖] *See* PETRI AFRIANI, Incriptionibus, p. 337; also LICETUS, FERRARI, and MONTFAUCON.

Many other equally credible narratives were current in the sixteenth and seventeenth centuries. At the time of the suppression of the monasteries by King Henry VIII. (1537) a tomb was opened containing a lamp which had been burning at least twelve hundred years: the authority of Cassidiorus was quoted, who says he himself made perpetual lamps for the use of the monks in his monastery at Viviers (about 500 A.D.). Reference was also made to the lamp of Pallas, son of Evander, whose brave deeds were sung by Virgil: this lamp was found at Rome about 800 A.D., and must have burned nearly 2000 years. Even St. Augustine, the most illustrious and holy Father of the Church, was claimed, by partisans of these traditions, as testifying to their truth. St. Augustine, mentioning the lamp in the Temple of Venus, says it "burned perpetually, and the flame adhered so strongly to the combustible matter that neither wind, rain, nor tempests could extinguish it, though continually exposed to the inclemency of the seasons." St. Augustine attempts to explain the marvel, and conjectures that the incombustible wick was made of asbestos, but that the inexhaustible aliment was the work of demons, who wrought the infernal miracle in order to blind the pagans more completely, and to attach them to the infamous deity worshipped in that temple.

The famous chemist Glauber refers to these miraculous lamps in his brief essay entitled "Book of Fires" (*Libellus Ignium*). He writes of a lamp "which, being closed up in a glass, may be made to burn continually by its own virtue, and give light without any other help." He explains the admitted fact that when the "secret fire" is "touched by the least air it extinguisheth and goeth out," by the suggestion that "the fire is appropriated to the Elemental Air," and hath its "own air in itself." Glauber, who was always ready to turn chemical discoveries to medical purposes, writes of this lamp that it may be "very available to those who, by reason of continual weakness, are forced to lie much upon their beds," and that it may be "kept continually burning in their bed-chamber, not only because of its clear shining light which doth neither smoak nor scent, like all other combustible lights, which scent is very prejudicial to the sick as well as to the healthy." *

Even in the eighteenth century we find anecdotes of these ever-burning lamps, clothed with new adornments and skilfully adapted to the later epoch. One of the most entertaining of these legends is that of Rosencreutz, the founder of the mysterious fraternity known as the Rosicrucians. The narrative runs as follows:—A certain person having occasion to dig somewhat deep in the ground, where the philosopher Rosencreutz lay interred, met with a small door having a wall on each side of it. His curiosity, and the hope of finding some hidden treasure, soon prompted him to force open the door. He was immediately surprised by a sudden blaze of light, and discovered a very fair vault. At the upper end of it was a statue of a man in armour, sitting by a table and leaning on his left arm. He held a truncheon in his right hand, and had a lamp burning before him. The man had no sooner set one foot within the vault than the statue, erecting itself from its leaning posture, stood bolt upright, and, upon the fellow advancing another step, lifted up the truncheon in his right hand. The man still ventured a third step, when the statue with a furious blow broke the lamp into a thousand pieces, and left his guest in sudden darkness. Upon the report of this adventure the country people came with lights to the sepulchre, and discovered that the statue, which was made of brass, was nothing more than a piece of clockwork; that the floor of the vault was all loose and underlaid with several springs, which upon any man's treading naturally produced that which had happened. Rosicrucius, said his disciples, made use of this method to show to the world that he had re-invented the ever-burning lamps of the ancients, though he was resolved no one should reap any advantage from the discovery."†

The Comte de Résie, in his curious "Histoire et Traité des Sciences Occultes,"‡ gives a brief account of the sepulchral lamps, and adds the following narrative:—In the reign of St. Louis (1226—1270) there lived in Paris a certain Rabbi named Jechiel, who was regarded by the Jews as a saint and by Christians as a sorcerer. He possessed a lamp which gave out light equal to daylight in brilliancy, which required no oil, and burned unceasingly. But what is more singular still, when honest tradesmen or people of quality came at night to knock at the door, his lamp shone brightly

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* GLAUBER'S Works. London, 1689. Part II., p. 216.

† Spectator, No. 379, May 15, 1712, written by EUSTACE BUDGELL.

‡ Vol. ii., p. 67, 1857.

as usual, and the Rabbi gave his friendly guests an entrance; but whenever impostors or persons of evil intent presented themselves at the door, the lamp grew visibly pale, and the Jew took care to fasten the door against the intruder.

The latter half of the seventeenth century witnessed a considerable controversy on the subject of perpetual lamps. On the affirmative side of the question we fine the names of the Abbot Trithemius, already mentioned; John Baptist Porta, the eminent Italian physicist, the same who invented the camera obscura ("Magiæ Naturalis," Libri xx., 1558); the celebrated Italian engraver and painter, Pietro Santi Bartoli ("Le antiche Lucerne, &c.," Roma, 1691, fol.); the German antiquary, Lorenz Beger ("Lucerne, vet. sep. Berol.," 1702); the learned Jesuit, Martin Antoine Delrio ("Essay on Magic," 1599), who attributed the lamps to magic skill; and Fortunius Licetus, the most credulous and erudite of all. On the negative side of the question are arrayed the names of Vigneul-Marville, a French Carthusian monk (1699); the learned Jesuit, Athanasius Kircher, whose "Mundus Subterraneus" has been already quoted; the Italian antiquary and Professor of Philosophy, Ottavio Ferrari ("Dissertatio de Veterum Lucernis," Padua, 1684, 4to., in Grævius's "Thesaurus Antiq. Ital."); the Italian ecclesiastic, Paolo Aresi, Bishop of Tortona ("Sacred Emblems," 1613); the English naturalist and antiquary, Robert Plot ("Phil. Trans.," Abr. III., p. 100, 1684; the German chemist, Libavius ("Comment. Alchem.," Part II., Lib. ii., Cap. x., 1595); Buonamici, an Italian *litterateur;* Fabricius; Montucla; and many others.

To detail all the points for and against the existence of perpetual lamps made by these writers does not come within the scope of this essay. One of the most earnest supporters of these fables, Fortunius Licetus, deserves a somewhat lengthier notice.

Fortunius Licetus was born in the State of Genoa, October 3rd, 1577. He was the son of a physician, and, having received a liberal education in medicine and philosophy, became professor of these departments of learning at the University of Padua. After holding these chairs for twenty-five years the rival University of Pisa secured his services by a tempting offer; but nine years later, a vacancy occurring at Padua, he returned to his former position, and held it until his death in 1657. Licetus was a voluminous author, writing fifty treatises on medical, moral, philosophical, antiquarian, and historical subjects, which were distinguished for their erudition, though he displayed little acuteness in research or originality of conception. His treatise "De Monstrorum Causis" (1668) abounds with instances of his credulity and with the superstitions and fables of his predecessors. Of all his works none is more celebrated than his treatise on the Sepulchral and Perpetual Lamps of the Ancients ("De Lucernis Antiquorum reconditis," Venet., 1652). This work, of 640 pages in quarto, is written expressly to prove the truth of the traditions concerning sepulchral lamps. The author accumulates a great number of witnesses, ancient and modern, quoting legends of Merlin, Porta, Scardeonius, and many others. The work is abundantly illustrated with engravings of the perpetual lamps, and forms a notable example of misplaced erudition and credulity. In his first book Licetus mentions thirty instances of perpetual lamps, including those connected with the mysteries of the Delphic Oracle, the ceremonies of Jupiter Ammon, and of the Vestal Virgins. The lamp of Demosthenes, which burned in the Temple of Minerva at Athens, also furnished him with a proof of the possibility of an inextinguishable fire. Licetus also relates the testimony of Jacobonus, author of the "Book of the House of Cesi," who mentions several persons who had seen these lamps still burning. He confidently relies on the testimony of such an unreliable author as Pausanias (175 A.D.), who speaks of a golden lamp, in the Temple of Minerva, which, when once filled with oil, burned a whole year without replenishing—a marvel which he attributed to the nature of the wick. Licetus refers to the statement of Plutarch, who relates that Cleombrotus, the Lacedemonian, visited the Temple of Jupiter Ammon, and saw a lamp which the priests said burned continually without oil.

Vigneul-Marville, writing of Licetus's work, very justly remarks that in it "Licetus exhausts all the resources at his command, but after all does not inform us of what we most want to know, viz., the secret of these perpetual lamps.

Many endeavours have been made by modern authors to account for the persistence of this belief by reference to natural causes. Montfaucon remarks no one doubts that burning lamps were placed in tombs by the ancients, and gives the following inscription from a tomb at Salerno:—"Adieu Septima; may the earth lie lightly upon you; may a golden oil cover the ashes of him who placed in this tomb a burning lamp." *

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* "Have Septima, sit tibi terra levis quisque huic tumulo posuit ardente lucernam illius cineres aurea terra tegat."

Certain writers suggest that the imperishable wicks may have been made of asbestos, or "salamander's wool" as it was called, but they encounter great difficulty in the matter of the "indestructible aliment." Vigneul-Marville ascribes the flames to the "fat and gross vapours engendered by the corruption of dead bodies and enkindled by the torches used in opening a tomb." Dr. Robert Plot, "Director of Experiments to the Philosophical Society of Oxford," read a paper before the Society, in 1684, in which he narrates experiments made to test the value of asbestos for lamp-wicks. He concludes that this material may have been used in the sepulchral lamps, and to account for the inexhaustible oil discourses on a spring of liquid bitumen, or naphtha, such as occurs in Shropshire : a similar suggestion was made by Athanasius Kircher as early as 1665 ("Mundus Subt.," *loc. cit.*). Other writers conjecture that the lights found in the tombs were of phosphorus—meaning thereby not the modern chemical element of this name, but the so-called "Bologna stone," which shines in the dark. The elder Disraeli briefly notices these remarkable legends in his "Curiosities of Literature," and points out the necessity of the oxygen of the atmosphere to ordinary combustion; he considers this fact in itself a sufficient refutation of these singular traditions.

II. NATIONAL SCIENTIFIC APPOINTMENTS.

MANY well-informed people, including not a few of those who hover round the outskirts of the scientific world, have but very vague notions concerning the manner in which many of our scientific officials are selected. We have heard the question asked whether appointments of this nature were obtained by influence, by examination, or, *rebus gestis*, by discoveries made and researches carried out. In consideration of our national cram-worship, it need scarcely have been doubted that we should, with rare exceptions, hold fast to the worst of all possible methods, that of competitive examination—a system which is year by year lowering our national position in the scientific world.

Facts have, indeed, lately come to light which might render all further argument needless if "cram," like many other absurdities, had not ninetyfold the "nine lives" which the popular proverb assigns to cats. The "Chemical News," in its "Students' Number" for the session 1879-80, informs us, on the authority of Prof. Huxley, that "not so very long ago a certain student, who had never handled a dissecting-knife, carried off the B.A. prize as well as honours in Animal Physiology by dint of an excellent memory, and is now a Government clerk, whilst a contemporary of his who in the same year carried off prizes and honours in Chemistry, without having ever cleaned a test-tube in his life, is now one of our leading musical composers and critics." What man of ordinary common sense can fail to see the absurdities which in these two cases lie piled up, layer upon layer? Or what unprejudiced mind can require further evidence for the necessity of a great and a total change?

An official document has lately been issued, announcing that "open competitive examinations" will shortly be held for two scientific appointments, viz., that of Assistant-Keeper in the South Kensington Museum (Science Branch), and that of Assistant Naturalist in the Natural-History Department of the Dublin Museum of Science and Art. The process consists of two parts. There is a preliminary scrutiny in hand-writing, orthography, arithmetic, English composition, and translation from Latin, French, or German into English. Without satisfactory proficiency be shown in all these subjects the candidate is allowed to proceed no farther. If successful, he is then admitted to the competitive ordeal itself, consisting of an "obligatory" and an "optional" branch. The former comprises in any case elementary mathematics, in which 500 marks are obtainable, and "any two of the seven following subjects: inorganic chemistry, which may count for 500 marks; organic chemistry, for 250; physics, for 750; zoology, 500; botany, 500; geology and mineralogy, 500; physiology, 500; and drawing, 500."

The "optional" department embraces any of the above seven subjects which the candidate has not selected as obligatory, and in addition any of the following:—"Higher mathematics (pure), 1000; theoretical mechanics, 500; applied mechanics, 500; French, 500; German, 500; Latin, 400; Italian, 400; Greek, 400; and English History, 400."

Having expressed our gratification that the examinees are not required to be "up" in heraldry, international law, book-keeping by double entry, Mexican archæology, &c., we may meditate sadly not so much on the mere "stiffness" of the examination as on its irrelevant character. From the remark that "Candidates for the situation of Assistant-Naturalist must pass in Zoology," we may safely infer that the duties of the post will mainly consist in the application of a thorough knowledge of the animal kingdom, and consequently that the man wanted must be above all things a zoologist. Yet the highest number of marks possible in this science is a poor 500 out of a maximum total of 9100, or not quite 6 per cent! Hence there is absolutely no safeguard that the best zoologist will be appointed! Neither botany nor even physiology is, by some strange oversight, demanded as essential. Hence it is quite conceivable that a man ignorant of these two branches of science, and endowed with a mere smattering of zoology, may still—if well versed in mathematics, physics, and in languages—completely swamp his rivals and win the prize. On the other hand, a biologist, "pure simple," a thorough specialist who has concentrated his whole attention and devoted his whole time to the study of organic life, is almost of necessity excluded. Suppose such a one selects as his two obligatory subjects zoology and physiology, and as an optional subject botany, and that in all three—as well as in elementary mathematics, which is inevitable—he gains the maximum number possible, or 500 marks in each; his total number will then be only 2000. On the other hand, let a competitor take 500 marks in elementary mathematics, 750 in physics, 250 in zoology, 1000 in pure mathematics, 500 each in theoretical and in applied mechanics, and 400 each in Greek and Latin, he achieves a total of 4300, and wins in honours. The true biologist is beaten in virtue, we had almost said, of his very superiority in his own department, or at least in virtue of that very concentration of thought and attention without which true greatness in any science is out of the question.

Another peculiar feature of these regulations is that the "optional" list, if taken in the gross, might possibly lead to a greater number of marks than the subjects in the "obligatory" list, even if the whole of them were taken up. To us it seems self-contradictory to admit that a science or a branch of knowledge is non-essential by placing it in an optional list, and yet to reward proficiency in it more highly than in the branches recognised as obligatory.

We may further point out certain omissions: the history of science, and especially of organic science, would be assuredly more to the purpose than English history. Animal geography, based as a matter of course upon physical geography, would also have been a useful feature. But these subjects seem to have escaped the notice of the Science and Art Department, or to have been crowded out by less relevant matter.

In what manner the examination will be conducted it does not, of course, appear. It is possible that the practical knowledge of candidates will be carefully weighed, and will stand them in more stead than any amount of mere words —that, *e.g.*, in zoology they will be called upon to name, or at least to refer to the correct order and family, specimens placed before them assigning grounds for such classification. But it is, on the other hand, possible that the whole affair will resolve itself into a question of verbal memory, and that the candidate who from his own mental emptiness most eagerly absorbs and most glibly reproduces the views of others will win the day.

These considerations naturally remind us that the "Regulations" hold out neither inducement nor reward for research. We might reasonably expect that in such a case original observations or experimental results might, according to their value, count for hundreds, or even thousands of marks, and if of pre-eminent merit might be held to decide the contest irrespective of all other points. But not so; investigations, however successful, and discoveries, however brilliant, count here absolutely for nothing, whether in the obligatory or in the optional department. Their very possibility is not taken into account, and their production would, we fear, be looked upon as little better than contempt of court. How many of the world's greatest naturalists would escape being ignominiously "plucked" if pitted, under such regulations, against candidates possessing an excellent verbal memory and accustomed to the "cramming" process? We have met with eminent men of science who admit that they would utterly fail if examined in their own published researches against men of this stamp.

The very root of the cramming system lies in the strange circumstance that the division of labour, so widely and so usefully recognised in the industrial arts, should still be deemed inapplicable in the sciences, and should even, in some influential quarters, be regarded as rank heresy. Ages ago the wise saw "Jack of all trades and master of none" was understood and acted upon in the practical world. But we still will not recognise a man to be master of any science unless he can be, or seem to be, "Jack" of all. Suppose we require a good ship-carpenter; we do not deem it needful to test his abilities in Turkey-red dyeing, or in glass-blowing, or in shoe-making. We are content that he shall be a specialist; we believe that all those powers of body or of mind which are required in his art can be best trained and developed in the acquirement and exercise of that very art. We do not fancy that a blacksmith requires to exercise his muscles by preliminary practice as an oarsman; we do not dream that a railway official or a pilot, in order to appreciate coloured signal-flags or fires, ought to serve an initiatory training in a dye-house. We go still further: we are apt to suspect the man who lays claim to proficiency in several arts or trades. We know that, however able and industrious a man may be, life is too short for the attainment of excellence in many different directions. We prefer the man whose whole time and whose individual energies have been concentrated on the subject we want, and, provided he gives us full satisfaction therein, we care little as to his "general culture." Even professional men are apt to suffer in the confidence of the public if it is known that they study any subject not strictly within the sphere of their more immediate duties. We have heard of a physician who had given much time and attention to the study of geology, and to the formation of a geological museum in the town where he lived. No one was, indeed, prepared to say that he had ever neglected a patient, or that he was out of the way if called for; still the people argued, roughly, but not in the main inaccurately, that he would have been a more able and successful physician had he not been a geologist, and he suffered in their opinion in consequence.

In scientific education, and in the preparation for certain professional careers, we do the very reverse of all that has just been described. We despise and reject the specialist, and call out for the "good man all round"—the man whose time and attention have been equally distributed. We forget that in these days each science has become so immense in extent that to keep up with the progress of discovery in one only branch is a task of no trifling magnitude, and that the Polyhistor of the day is a mere superficial trifler. To act on our present principle is not only to waste time, but to run the risk of acquiring habits of thought foreign to our immediate purpose. If a student has to learn to distinguish nicely between peculiarities of form, of texture, of colour, odour, and the like, he will not be greatly aided by turning his attention to words and abstractions.

So long as we insist upon general culture as obligatory, "cram" will flourish, denounce it as we may. The only way to its extinction, and consequently to thoroughness, lies through specialism.

III. HABITS OF ANIMALS IN RELATION TO THE WEATHER.

By the Rev. S. Barber, F.M.S.

THE habits of animals, and notably of the insect world, have for ages been admitted into the category of indicators of weather change. Much difficulty, however, has been found in interpreting these habits and movements, —a difficulty only to be overcome by long-continued, patient, and close observation of particular species. It is indeed somewhat remarkable that popular attention has been arrested, in this respect, by the habits of various species to which in a general way but little credit is given for intelligence, sagacity, or sensitiveness.

To associate the movements of ducks and geese (especially in a wild state) with weather changes in regard to rain and floods, which affect their habitations and supply of food, seems natural enough; but we find also such animals as the ram, the pig, and other thick-skinned creatures recognised as prophetical in weather lore and popular tradition. There is something taking in the notion of an astronomer gaining information of the approaching storm from the wagging of a ram's tail; and those whose occupation entails respect for, and attention to, the animal world, are often disposed to attribute to dogs or swine faculties denied to themselves, —as, for example, that the former are cognizant of spiritual phenomena, and that the latter can see the wind. The researches of modern zoologists* have certainly brought to light an amount of intelligence among the lower orders of animals that we little suspected in former times; and the attempt to elicit and develop, by careful training, such intelligence, has become to many an interesting pastime. We notice, also, that an exceptional regard to the habits of particular species has not only found an embodiment in the

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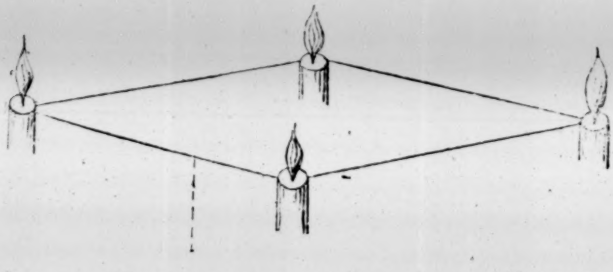
*** Recently the researches of Dr. M'Cook in regard to the ant deserve especial attention.**

popular superstitions of various nations, but has even crept into their sacred writings. This result is perhaps partly due to the fabulists and moralists who have utilised familiar objects in order to convey moral and religious truths more pleasantly to the people. But the more rigidly scientific and exact methods of modern enquiry have tended to reveal more fully, to reflective minds, the *harmony* of Nature, the perfection of the various parts of her machinery, and their adaptation to one another; and also to show how the great Author of Nature has adjusted the springs with unerring hand, making precise compensation in the balance, and distributing with infinite wisdom both intelligence and force.

Certainly there is much more scope for enquiry among the lower creatures than many persons are aware of, as a careful study of the ant, the bee, or the spider will reveal, and has, in fact, revealed in recent times.

The following incident may serve as an illustration both of the mechanical dexterity and audacity, and also of the occasionally *social instinct*, of the last-mentioned creature; and possibly of the same law under which birds become tame upon the approach of severe weather:—In the autumn of 1878, upon a table on which the writer was dining, four candles were placed in an elongated diamond-form. They had not been lighted long when a tiny spider, scarcely larger than a pin-head, was observed to have hung his lines after this fashion (see figure):—



SPIDER'S WEB ATTACHED TO SUMMITS OF CANDLES.

The summits of the candles were connected by a single line, rigidly strung, and uniting the very cups formed by the heat of the flame rising from their centres. It seems absurd to suppose that such a delicate thread could have been floated into this symmetrical form by atmospheric agency, in a room where the currents of air would necessarily be much disturbed; especially if we consider the fact of the flames being less than half an inch from each point of attachment to the candles. It would, again, be equally absurd to imagine that the tiny creature had ascended each candle separately, drawing the line after it, as the table must have presented numerous obstacles to this method of construction. The probable method in such cases seems to be that the lines are projected with precision from one point of adherence to another; possibly they are weighted for the purpose. This would appear to be the only way of placing a delicate filament in so extraordinary a position; and that it is the actual method used, I had, soon after the above-mentioned incident took place, a strong proof.

A small spider appeared suddenly upon the sheet of paper on which I was writing. I advanced to the window, holding the sheet in my hand, to inspect the stranger. In the other hand I held another sheet of paper, the edge of which I placed within about a foot of that on which Sir Spinner was disporting himself. Having ascended to the edge, he at once darted over the intervening space with such rapidity as almost to elude vision. It seemed that he had projected a line, with great precision, to the opposite side of the gulf, the very moment he gained the "point of vantage," and then had sped across with lightning rapidity, drawing up the line as he advanced.

Speaking of *Araneæ*, I may mention in connexion with the severe winter, 1878-79, that, shortly before the frost began, I noticed several of the smaller species in a half-torpid state upon lines dropped from the old-fashioned high mantel-shelf in my room. They remained motionless for a considerable time in mid-air, apparently enjoying the warmth.

Here we have probably an instance of that tameness which finds another expression in the approach and entrance of small birds into human dwellings when intense cold is near at hand. Whether this change of habit arises from a vague anticipation of misfortune and a consequent craving for sympathy, or merely from the failure of the food-supply depending on the existence of creatures weaker than themselves, it seems evident enough that there is a consciousness of the fact that man is to a certain extent the controller of Nature's resources and the almoner of her bounties.

The Meteorological Society, in publishing its "Phenological" Observations, has fully recognised the importance of noting first and last appearances; and in the Entomological Report Mr. Griffith puts in a claim for the spiders. He alludes to their supposed remarkable perception of the *probable future condition* of the atmosphere; and notes the opinion expressed by M. De Tijonval, that their first appearance should be proclaimed with the "sound of trumpet."

A connexion between the movements of the animal world and the revolution of the seasons has been observed since the earliest dawn of Science, and to explain those movements may still furnish problems for the acutest of naturalists; but it would appear to be inferring too much to conclude, from their ordinary migrations, a possession of prophetic *insight* into the course of the weather. It seems more rational to believe, with regard to most of these appearances, that it is by virtue of their highly-developed senses and peculiar nervous organisation that some species become predictive *in their habits*. Whether the supposed presentiment which induces them to deviate from their normal line of action arises simply from a vague feeling of disquietude, or results from an actual perception and connotation of various phenomena which escape the human observer, is very difficult for us to decide.

To observe with exactness and to compare notes in a certain fashion are arts in which many insignificant creatures excel, and human beings are very apt to underrate both the power of observation and of "co-relating" in animals. The very conditions of their existence give them indeed an advantage as compared with the more artificial life of man, inasmuch as they are more *en rapport* with the physical forces of Nature, and more in harmony, therefore, with their onward movement.

It has been said that, in regard to weather prediction, the conditon of the barometer cannot, in any direct way, be regarded as prophetical, as it simply registers the *present* condition of the superincumbent air; yet by virtue of the association of phenomena, it must be allowed to be *practically* prophetical, inasmuch as it registers conditions which, in a general way, have a certain sequence.

And it appears that this simple law of the association of phenomena applies also, and with perhaps greater force, to the movements of the animal world: for it can scarcely be doubted that animals are in many cases highly sensitive recorders of atmospheric influences, and that they often register the action of those more subtle forces to which the movements of the barometer are less intimately related.

IV. THE TEMPERATURE OF THE SUN.

By W. Mattieu Williams.

IN the last number of the "Monthly Journal of Science" Prof. Langley compares the radiations from the sun with those from a surface of molten metal which presents to the thermopile a disk of equal angular diameter, and bases his estimate of an inconceivably high solar temperature upon this experiment.

If we had any reasons for concluding that the surface of the sun is a heated solid, or liquid as athermanous as molten iron, his method might justify his conclusions; but all we know of the sun leads to the conclusion that the photosphere is composed of flaming or incandescent gaseous matter, the outer or superficial strata of which are permeable by the radiations from the incandescent matter below or within. If so, it is evident that the effective radiations from such a body must be increased, not merely by the extent of its surface, but also by the thickness or depth of the diathermanous incandescent matter; and a comparison between a disk of this and another similar disk of an athermanous body that radiates only from its surface must be quite delusive when applied for comparing their *temperatures*. This may be illustrated by simply presenting a plate of heated iron to a distant thermometer or thermopile, and then carefully placing behind this another plate of equal or less diameter, and equally heated. If direct radiation from the second is prevented, the thermometer will not rise when it is placed behind the first. Now try a similar experiment with two gas flames, and the effect of the radiation of the second flame *through* the first will be seen at once, though the surface of flame presented and the thermometer remain the same, and the temperature of the first or front flame is not sensibly raised.

In Chapters 7 and 8 of "The Fuel of the Sun" I have described a series of experiments made for the purpose of determining the transparency and diathermancy of flame to its own special radiations. The experiments on transparency were conducted with the advantages of the best attainable apparatus, — the photometer and dark chamber of the Official Gas Examiner of the Sheffield Corporation,—and the results showed that with proper precautions, there described in detail, the light received upon the screen of the photometer from a given number of gas-jets, each burning an equal quantity of gas per minute, was the same whether the jets were arranged with all their surfaces presented to the screen, or with the surface of only one presented, the others being ranged behind that one and at equal mean distance to the larger surface; or, in other words, that thickness or depth of flame is a factor of equal value to that of surface area. The flame itself was found to be transparent, but the products of its combustion not so. The diathermancy of flames was similarly tested, but with inferior apparatus. The results showed that every additional flame placed behind others increased the thermal radiations from a given restricted area facing the thermometer; but the increase was not so strictly proportionate to the quantity of gas consumed as in the case of the luminous radiations. The variations, however, were not greater than the limits of error due to the rude experimental appliances.

Further investigations are demanded for reliable quantitative determination of the amount of thermal radiations which will pass through a flame or flames of given thicknesses. My experiments *indicate* (though not sufficiently delicate to *prove*) that a flame offers no resistance at all to the passage of the thermal radiations from a flame similar to itself; and if I am right, the vast energy of the solar rays demand no preter-terrestrial *intensity* of temperature in the sun, but merely a great *quantity* of heat, due to a great depth of flame of no higher temperature than is produced here on earth by the re-combination on the photosphere of those elements which we are justified in regarding as dissociated in the interior or lower regions of the solar envelope, and re-combining in the photosphere.

As Prof. Langley is familiar with the phenomena of the Bessemer process, I will direct his attention to a magnificent illustration of the effect of body or thickness of flame which it affords. Every chemist knows how feeble is the luminosity of the blue flame which accompanies the combustion of carbonic oxide. When the spiegeleisen is poured into the Bessemer converter some of the carbon of the spiegel combines with the oxygen of the fused oxide of the blown iron, and a huge blue flame of unmistakable character emerges from the mouth of the converter. Its intrinsic luminosity is visibly small, comparable to that of the flame we produce in the lecture experiment of decomposing oxalic acid in a test-tube, and lighting the carbonic acid at the tube's mouth. The radiant energy of this body of pale flame (which has no hollow centre like common flames receiving their oxygen from the outside atmosphere) is nevertheless wonderfully great, as may be seen by observing its illumination of distant objects. The Bessemer shop at Sir John Brown and Co.'s Works, Sheffield, had window-openings at the sides and roof; and standing on Grimesthorpe Hill, half a mile away, I have frequently, on misty nights, seen beams of light pouring through these openings, and stretching to the low clouds, on which the image of the opening was projected as on a screen. In all weathers the night illumination of these windows by the carbonic oxide flame was magnificent.

It appears to me that this subject is of great philosophical interest. If the sun has a temperature approaching that assigned to it by Prof. Langley and others, all hopes of studying solar physics by comparison with terrestrial phenomena are at an end. The revelations of the spectroscope must be but snares and delusions, since the activities of gaseous molecules or atoms incandescent at such temperatures should set their wave-lengths and refrangibilities at such variance with those in our laboratories that we must either fail to recognise them or remodel our accepted theories of radiation. If, on the other hand, they have temperatures similar to those produced by the combinations of terrestrial elements, we may venture to accept the conclusions of the spectroscopist concerning their identity, and reason upon possible effects of their dissociation and re-combination, our reasoning being then based on the only data we possess, viz., terrestrial experience.

V. LONGEVITY, OR THE NATURAL DURATION OF LIFE.

THE subject of Dr. Richardson's Opening Address at the Croydon Congress of the Sanitary Institute of Great Britain, recalls to our mind an admirable paper "On the Longevity of Brain-Workers," read at a Meeting of the American Public Health Association, in 1874, by Dr. George Beard, of New York.* Dr. Beard wished to prove the error of the accepted teachings in regard to the effect of mental labour. He therefore obtained statistics on the general subject of the relation of occupation to health and longevity from the registration reports of England and America, and he also studied the lives of many prominent brain-workers. So far from confirming the generally-received theory that the mind can only be used at the expense of the body, his researches led him to conclude—

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* Quarterly Journal of Science, vol. v. (N.S.), p. 430.

1. That the brain-working classes—clergymen, lawyers, physicians, merchants, scientists, and men of letters —live very much longer than the muscle-working classes.
2. That those who follow occupations that call both muscle and brain into exercise are longer lived than those who live in occupations that are purely manual.
3. That the greatest and hardest brain-workers of history have lived longer on the average than brain-workers of ordinary ability and industry.
4. That clergyman are longer lived than any other great class of brain-workers.
5. That longevity increases very greatly with the advance of civilisation, and that this increase is too marked to be explained merely by improved sanitary knowledge.
6. That although nervous diseases increase with the increase of culture, and although the unequal and excessive excitements and anxieties attendant on mental occupations of a high civilisation are so far both prejudicial to health and longevity, yet these incidental evils are more than counterbalanced by the fact that fatal inflammatory diseases have diminished in frequency and violence in proportion as nervous diseases have increased; and also that brain-work is, *per se*, healthful and conducive to longevity.

The title of Dr. Richardson's Address was "Salutland; an Ideal of a Healthy People." About three months ago Dr. Richardson and Mr. Chadwick discussed with Professor Owen the question of longevity and the natural duration of life of different classes of animals.

"With his usual scientific accuracy and industrious research, Owen had estimated, from various data he had collected, the natural term of life of that curious animal, the hippopotamus. He had learned that its term of life is thirty years. He explained to us the mode by which he had arrived at that fact; how into the calculation it had been necessary to take into account the dentition of the animal; the stages of development; the natural wearing out of the teeth; the period of gestation; the development of the skeleton into the perfection of a bony fabric, with particular reference to the combination of the epiphyses or loose ends of the bones to the shafts of the bones; and lastly, the pathological or diseased condition of the dead animal of the species that had arrived at its full longevity, in order to determine whether or not there was evidence of cause of death from disease of some particular organ, or whether there was no such evidence, but simply a history of general decay from old age pure and simple.

"We were told that in a hippopotamus which had recently died, and which was known to have just turned thirty years of age, the two sets of teeth had fulfilled their allotted duty; that the bones of the skeleton were duly consolidated; and that the organs of the body were equally degenerated; so that death had occurred not from failure of any particular organ, but from failure of the organic parts altogether. In a sentence, the animal had died a natural death, and the constant of the term of life of it and its family was set down at thirty years, a constant to which all the facts that could be collated in respect to this species of animal definitely pointed.

"From this line of facts in respect to one type of animal life we were led to others, and the rule laid down by the distinguished Flourens—by which the determination of natural old age is calculated on the basis of perfected maturity—was brought under review. The skeleton is perfected when the epiphyses or loose terminal parts of long bones are firmly united with the shaft of the bone. When the date of such perfection of development is known in the mammalian class of animals, the simple process of multiplying the age at that date by five gives the natural anatomical life of the animal. The elephant came before us as an example. A young elephant, whose history has been related in the "Philosophical Transactions," died at the age of thirty years. At that age the epiphyses of its bones were not completely united with the shafts. It was nearly, but not quite, matured. Multiply thirty by five, and one hundred and fifty years stand as the natural estimate of the life of the elephant; so that really an elephant might exist which had itself carried all the Governors-General of our Indian Empire. Moving from this animal of long life, we turned to the camel, to find full maturity at eight years, full life at forty. We turned to the horse, to find full maturity at five years, full life at twenty-five. We turned to the lion and the ox, to find full maturity at four years, full life at twenty. We turned to the dog, to find full maturity at two years of age, full life at ten. We turned to the cat, to find full maturity at eighteen months, full life at seven and a half years. We turned to the rabbit, to find full maturity at one year, full life at five.

"From these contemplations our minds very naturally reverted to the animal, man, to the members of the human family. Man, we learned, follows the same rule as the rest of living beings. Judged by the same test, his full maturity and full age may be calculated with equal precision. His maturity—perhaps not quite the full maturity—is twenty years. His full age, therefore, is one hundred years. This is the anatomical estimate of human life, the surest and by far the best of all that can be supplied, since it defines a law irrespective of and over-riding all those accidental circumstances of social and physical storm and strife which may interfere, and indeed do interfere, with every estimate based on the career of life itself, as it is shown in the ephemera by and through whom it is phenomenally demonstrated."

"This lesson," Dr. Richardson continues, " struck Mr. Chadwick and myself with singular force. On a surer basis than we ever trod, it corroborated a view we had ourselves promulgated from entirely different stand-points: and it further corroborated a similar view which had been advanced by our eminent friend, Dr. William Farr. We were led, in a word, once again, to the inevitable conclusion that man, even in this stage of his probation on the planet, is naturally destined to walk upon it, endowed with sensibilities of life and intelligence, for a period of one hundred years, and that until he realises this destiny practically he is—in value of physical life—actually degraded far below his earth-mates whom he designates the brute creation, and over whom he presumes to exercise his, to them, almighty will.

"To certain parts of the scheme of natural life there is a boundary. The period of maturity of development has its boundary of twenty years,—when the body, as Flourens says, ceases to grow; but if it ceases, in the ordinary sense of the term, to grow, it does not cease to increase; its nutrition improves and perfects for twenty years more at least, and then only has reached its completed physical condition. It should never from that period gain in weight, and for a long time it should not lose. It goes on now through a third period, which Flourens admirably calls the period of invigoration, during which all its parts become firmer, all its functions more certain, all its organisation more perfect;

and this period covers thirty years. At seventy old age begins; the *first* old age, in which naturally the fruits of wisdom are most bountifully developed, and which lasts from fifteen years to twenty, to mellow down to a period of *ripe* old age, commencing at eighty-five years and lasting fifteen years more, *i.e.*, until the constant is attained.

"And yet there need not now be death; for though, as Lord Bacon has said, old men are like ruined towers, and though, as Flourens has quoted, youths live in a double sense, with forces in reserve and forces in action, *vires in posse et vires in actu*, the *radical* forces and *acting* forces of Barthez, while old men live only on the forces in action, '*vires in actu*,' possessing no reserve, it is wonderful how the forces in action will continue after the reserve is withdrawn. This kind of half-life has continued unquestionably many years beyond the fulness of age, both in man and lower animals, and to give it twenty years beyond the natural hundred is to be just without being in any extreme sense generous.

"What we call death is gravitation; what we call disease is some accidental shot inflicted, it may be, while still the self-resistance to gravitation is in operation; what we call natural death is the gradual overweighting, at different periods, of the natural powers, reserve and acting, by the persistent force that bears us down. We cease to grow at a certain stage of our life, because of the resistance of this downward force; we cease to increase in size from the same cause; we consolidate in structure from the same cause; we bend in old age from the same cause; and we die from the same cause. Every step has practically been a death from the same cause.

"If the civilised world would continue in the ascendant, it must learn to live. An average life of forty-one, and under favourable circumstances of forty-nine years, with a world of disease and death up to that period, and a scattered struggle of the fittest for an exceptional existence into ripe old age, cannot maintain the relative efficiency of any nation, except in a world universally and equally bad."

As an answer to the question how civilised man should live in order that the natural term may be found, Dr. Richardson created an ideal people, having an ordinary term of life of one hundred, and prospective term of one hundred and twenty years.

This ideal people, believing that all cities have an equal right and an equal importance, possessed no capital city, no special seat of government, no professed politicians, no army, no lawyers, and no paid physicians, every inhabitant possessing a knowledge of the laws of life and health. Animals are, however, used by this model people. Their fleeces are used for clothing, their milk for food, and many of them are made to work. The elephant works with an intelligence and skill that is almost human, and with a power that is superhuman, so that he is one of the most useful and faithful, and best-beloved of all the lower animals in the land. He is the rival of the horse, which is also much cared for, and is bred in a state of great perfection for bearing the rider, to which duty he is mainly consigned.

The roads leading from one part of the country to the other are maintained in the most perfect efficiency, smooth in all parts, and dry as our best asphalte of to-day. Transit along these highways on horseback and by velocipede has supplanted most other modes of personal conveyance. The cost of coal has rendered steam locomotive power very limited, while aërial locomotion has replaced steam-propelled carriages in a marked degree. But that which has effected the greatest change in respect to locomotion has been the facility with which persons in all parts of the Commonwealth can converse by telephone at any distance from each other, the act of journeying at a pace above 40 miles an hour being considered an unnecessary expenditure of means and physical energy.

In the course of scientific development the philosophers of Salutland were led slowly to the demonstration that, in every case, crime and insanity are synonymous psychological conditions. Descending from the highest insanities to the lower and the lowest, they traced out perfect analogy; they detected that on matters of crime many men and women might be mad, while on other matters they were sane, and even capable of performing good and useful works. Thus, analysing natural facts, they became in time bold enough to act on what they had learned. The man who can commit a crime is insane, and must be treated accordingly. To punish such a man in the ordinary meaning of that term is to try to cure one crime by committing another, which is absurd, and would be an indication of general insanity. So the insane man from crime is put with the other insane. He is moved with them to a separate colony, where, according to the nature of his offence and the character of his affection, whether it be deeply hereditary or not hereditary, and so on, he is subjected to a seclusion in which he can do no one any harm, and to such supervision and improvement as may render him fitted to re-enter society. His banishment is softened by the permitted visits of friends, and when recovery is completed he is free. But in confirmed cases where the criminality is incurable, the law is inexorable: incurable mad men and mad women, treated with all imaginable care and consideration, are retained apart to the end of their lives. They must not corrupt others. Most of all, they must not be the fathers and mothers of a new progeny, corrupted by that most silent and potent of all corrupting influences, hereditary taint.

The education of this ideal people is never forced. Hard examinations, prizes, rewards for work,—all these stimulants would be held as mentally poisonous, mere excitants of local emulation, to the exclusion of the general. Learning is universally appreciated, and the office of teacher is amongst the very highest in the social scale.

It is, further, a part of the whole economy of the Saluts that they never dream either of killing themselves or injuring themselves by work on the one hand, or by retirement from work on the other. They hold that a human being is constructed to perform a certain amount of work. His heart is born to deliver a certain number of beats,—say, in one hundred years of natural life, three billions six hundred and fifty millions of beats. He is constituted to develop in the various organs of his body so many trillions of active cells, which make up his molecular organism, and which, duly supplied with force derived from without, are capable of performing so much work as they live and die. More force of heart, more development of cells, more life in short, no man or woman can ever possess than that with which they are primitively endowed, as far, at all events, as are yet known, and all the free will in the world cannot change this one fundamental fact. At the same time free will can do this much: it can use its own as it likes; it can wear out its cell life altogether equally and sedately, and so live the whole allotted time, keeping a good margin; or it can wear out its cell life altogether and rapidly, leaving no margin; or it can wear out the cell life of one particular organ—brain, heart, stomach, liver, kidney—by excessive use and exhaustion of the cells of such organ, and so can kill the whole organisation by the death of one organ, the rest of the organs being still in condition, perchance, for years of activity. He only should retire from active work from whom work retires, is another idea and practice so faithfully followed that every town yields many workers who, like Titian the Great, are doing their full quantity at the centenaries of their births. For all necessary purposes—such is the easy and equal distribution of labour, and so comparatively light are the tasks of labour—from three to four hours in the twenty-four are sufficient for everything that needs to be done, by the busiest of the busy, to keep the social machine in perfect order.

Thus, in Salutland, ample time is left for the pursuit of every useful, healthy, and ennobling occupation. Its happy people cultivate every beautiful and refined art, every branch of natural science; their literature, chiefly of Nature and of Life, and History of Life, while it has lost none of the brilliancy and point of the present rapid method, is deeper and richer and newer. The age of criticism has passed away. To visit all the planet, make the grand tour of the earth; to know all history by biography, so that no man or woman who has helped humanity a hair's-breadth on its way may escape their appreciative and correct knowledge; to compare all artistic existence with the nature from which it sprang; to read men through the languages they have spoken; to study the physical directions of mental phenomena, and from the repetitions of history to forecast even history: these are the studies of their learned men, and the texts from which the learned impart their stores of erudition. To perfect these studies every means is offered by which, without prize-giving or other false stimulus, the choicest rivalry may be naturally imported. Music is most perfected. The stage maintains its reputation, and is utilised to the grandest purposes. Art in the form of sculpture is encouraged with the greatest care. Architecture is another profession which vies in splendour. Here, too, the true painter has found a home. Science is the unembodied Nestor of the teacher and the taught. To know is to exist; and Science is knowing, existing. For the museums of Science, the collections of the works of the Universal Father, the architect expends his best designing energies, the builder his finest work, the mechanist his choicest skill. Astronomy still heads the line of the pure sciences, chemistry follows, and meteorology, geology, natural history, anthropology, mechanics, and engineering, and other sciences find all their true places. Health science stands alone; it includes all the rest. *Salus salutis; scientia scientiæ.*

While thus, in systematised order, the gentle and refining arts and sciences are cultivated as exercises for the mind, the physical health is tended with equal care. Out-door life is the first thought, and out-door exercises of a skilful and useful character are to the fullest extent encouraged.

All the young are taught to swim, to row, to ride, to skate, to walk with ease and stateliness, to climb, to play at invigorating games, to dance, to speak in public, and to become efficient in the gymnasium. The daily ablution in the bath, the daily exercises of muscle and limb, are made as distinctive necessities as the taking of meals; and, withal, the dress in which the body of both sexes is clothed is made so loose and obedient to every movement that no deformity of body from dress is possible.

With regard to the health of the Saluts they have mastered the pestilential diseases. An epidemic from pollution of air, of water, of food, is with them impossible. The hereditary tendencies to disease are either lost altogether or are so nearly eradicated as to be practically removed. The diseases incident to poverty are stamped out by the removal of their cause. The diseases incident to intemperance and luxury are stamped out by the removal of their causes. The diseases incident to occupation are stamped out by the careful and easy expunging of everything that is injurious in occupations. The diseases incident to worry are stamped out by the abolition of maddening, exhausting, and useless strifes and ambitions. In a word, this people contends only with the natural elements,—the heat of the sun, the flash of the lightning, the changes of atmosphere,—from the fatal effect of which they rarely suffer; and with the one destroying inevitable power, the gravitation of the earth, which brings old age and death.

Thus, with the fewest accidental exceptions, the men and women attain the sacred age. Their death-rate is normal and constant, at eight in the thousand per year, and death itself—painless, final sleep—is hardly more than departure to rest when the day of work is done.

Referring to the simple means by which these results were achieved, Dr. Richardson says these settlers had become indoctrinated in their own land with the elementary truths relating to public health. They had learned the lesson of physiology; they had acquired a certain knowledge of what were and what were not healthy places. They had learned the history of the diseases produced by uncleanliness, had become practised in the useful and innocuous distribution of sewage, and had seen the dangers that arise from pitching dwellings in damp localities, and in building dwellings with materials that absorb and hold water. In accord in spirit, with the best information on these points, they carried out the spirit to the letter in their practice, and so began on a new and sound foundation. Ignoring all thought of false economy, destroying by fire all carriers and sources of contagion, and providing for the instant isolation of every case of contagious or infectious disease, they stamped out the communicable diseases wholesale, with a success and readiness which were surprises even to the most sanguine preventionists, and which gained for them ten years of life.

The science of medicine, which in its true and honest position is always in the front rank of advancement, was somewhat changed. The doctors continued to keep a correct history of diseases, of the course of diseases, and of the causes of diseases, but they added an equal knowledge of prevention, particular and general, and valued that knowledge most. Dismissing all special modes of cure by particular systems or assumed specifics, they determined to know once and for ever what diseases would not get well without the aid of medicines of any kind, the general conditions for recovery being rendered as perfect as was possible. This discovery of the triumph of preventive art did not, however, satisfy altogether. It left on record the fact that Nature never goes out of her path to cure, and that what has been called the *vis medicatrix naturæ* was as much a myth as any other of the past myths of physic. It left on record, also, that under the happiest apparent external conditions some diseases will run their fatal course as decidedly without medicines as with them.

The diseases which so progressed were, in turn, discovered to be diseases of what we call constitutional type, depending upon heredity. They were four in number: scrofula, with its attendant, pulmonary consumption; cancer; specific disease; and insanity. The majority of the physicians, seeing the results I have named, began at once to teach that, as these diseases were obviously diseases of descent, and were maintained by the intermarriages of persons subject to them, there was only one sure and certain mode of removing them, and that was a common-sense rule that such intermarriages should not be tolerated.

The physiologists, dealing with the two questions of digestion and food for digestion, were led to the conclusion that a considerable shortening of life was induced by the excess of work which was put on the digestive organs. They bore in mind that many persons die from the wearing out of one particular organ, the rest of the organs being still healthy. Of all organs they agreed the stomach is most exposed to this danger. They found, on inquiry, that the stomach was distressed both by quantity and quality of food. Following a suggestion thrown out by Flourens, they decided, on anatomical grounds, that man was neither herbivorous nor carnivorous, but a frugivorous, or fruit-eating animal. Next they estimated the precise amount of food and of drink that was necessary to support the reserve and the active life in the varied stages of life. Again, they determined the reduction of food that is required when the reserve life is withdrawn, and when the active life being left alone, it is the more requisite that no additional surplus of tissue or fluid, fat or water, should encumber the body; that no excess of force should be supplied to the digestive organs to the deprivation of other organs equally important, and that no over-taxation should be cast on the digestive organs themselves. Step by step, they were led hereupon to the introduction of an entire change of food and feeding. Animals were given up as sources of sustenance; fruits became greatly in demand; the bread tree competed with wheat grain; the banana and the grape were called largely into use; the juices of fruits almost entirely superseded water as beverages; while chemistry, coming in always to the assistance of man, easily transmuted many vegetable substances into the most perfectly digestible of foods for every variety of age and constitution. Of purely animal substances, milk only, and the products of it, butter and cheese, retained full sway. Of the vegetable kingdom not frugivorous, cereals, pulses, tomatoes, potatoes, and other fresh vegetables, with the edible Fungi, retained their useful place; and in respect to quantity of food and drink, not more than half by weight began to be consumed compared with what had been consumed before.

The last of the later advancements in order of time, and the final in order of complete accomplishment of obedience to natural design, had relation to sleep and rest. When the sun became the fellow-workman of the people of Salutland, the redemption of their bodies from premature death was carried out with the fullest success. The people saved millions in money, but this was nothing to the other saving. That nervous system of theirs—that system which takes in the outer universe, which is stirred by its waves, and sleeps, if it be permitted, when the waves sleep—found at last its natural time for work and for rest. All Salutland laid down like one vast living world to enter oblivion, and to wake from it filled with another spell of life, ready and happy to greet another day.

If there were any hope of Dr. Richardson's city and people having any other than an ideal existence, we might dismiss from our minds the arguments put forward by Dr. Beard in support of his theory; but as there is no likelihood of such a state of perfection being reached, at all events in the present generation, it will be well to consider the conditions which favour the brain-worker, with the view of extending some of them to the muscle-worker, or at any rate of improving his social and intellectual condition. The causes to which Dr. Beard attributes the greater longevity of the brain-working classes are—1. The inherent and essential healthfulness of brain-work. 2. Brain-workers have less worry, and more comfort and happiness, than muscle-workers. 3. Brain-workers live under better sanitary conditions than muscle-workers. 4. The nervous temperament, which usually predominates in brain-workers, is antagonistic to fatal, acute, inflammatory disease, and favourable to long life. 5. Brain-workers can adapt their labour to their moods, and hours and period of greatest capacity for labour, better than muscle-workers.

The study of vital statistics led Dr. Beard, moreover, to the conclusion that, other conditions being the same, the greater and richer the brain the greater the longevity; and he shows that the greatest men of the world have lived longer, on the average, than men of ordinary ability in the different occupations by fourteen years; six years longer than physicians and lawyers; nineteen or twenty years longer than mechanics and day labourers; from two to three years longer than farmers; and a fraction of a year longer than clergymen, who are the longest-lived class in our modern society. The causes of this exceptional longevity are—1. Great men usually come from healthy, long-lived ancestors. 2. A good constitution usually accompanies a good brain. 3. Great men who are permanently successful have correspondingly greater will than common men, and force of will is a potent element in determining longevity. 4. Great men work more easily than ordinary men.

VI. ATLANTIS NOT A MYTH.

By Edward H. Thompson.

OUR sturdy worker in the copper mine of Lake Superior, finding both himself and his vein of copper growing poorer day by day, determines to seek some more paying claim in the as yet unexplored portion of the copper country. He gathers his kit of tools together and starts, and, after many a hard hour's travel over the wild and rugged country, finds a region with abundant signs of copper, and where seemingly no human foot has trod since creation's dawn.

He strikes a rich vein, and goes steadily to work digging and blasting his way to the richer portions, when suddenly, right in the richest part, he finds his lead cut off by what looks to his experienced eye marvellously like a mining shaft. Amazedly he begins to clear out of the pit the fallen earth and the *débris* of ages, and the daylight thus let in reveals to his astonished gaze an immense mass of copper raised some distance from the original bottom of the pit on a platform of logs, while at his feet lie a number of strange stone and copper implements,—some thin and sharp like knives and hatchets, others huge and blunt like mauls and hammers,—all being left in such a manner as though the workman had but just gone to dinner and might be expected back at any moment. Bewildered, he ascends to the surface again and looks about him. He sees mounds that from their positions are evidently formed from the refuse of the pit, but these mounds are covered with gigantic trees, evidently the growth of centuries; and, looking still closer, he sees that these trees are fed from the decayed ruins of trees still older—trees that have sprung up, flourished, grown old, and died since this pit was dug or these mounds were raised. The more he thinks of the vast ages that have elapsed since this pit was dug, that mass of copper quarried and raised, the more confused he becomes; his mind cannot grasp this immensity of time.

"Who were these miners? When did they live, and where did they come from?" are the questions he asks himself, but gets no answer. However, one fact is patent to him—that, whoever they were, they will not now trouble his claim; and, consoled by this reflection, he goes to work again.

The traveller in wandering through the dense and almost impenetrable forests of Central and South America suddenly finds himself upon a broad and well-paved road, but a road over which in places there have grown trees centuries old. Curiously following this road he sees before him, as though brought thither by some Aladdin's lamp, a vast city, a city built of stone; buildings that look at a distance like our large New England factories; splendid palaces and aqueducts, all constructed with such massiveness and grandeur as to compel a cry of astonishment from the surprised traveller; an immense but deserted city, whose magnificent palaces and beautiful sculpturing are inhabited and viewed only by the iguana and centipede. The roads and paths to the aqueducts, once so much travelled as to have worn hollows in the hard stone, are now trodden only by the ignorant mestizo or simple Indian. Of this deserted home of a lost race the traveller asks the same question as the miner, and the only answer he gets from the semi-civilised Indian is a laconic "*Quien sabe?*" And who does know?

The curious and scientific world, however, are not so easily answered, and various are the theories and conjectures as to these diggers of mines and builders of mounds and strange cities. One of the most plausible of these—one believed by many scientists to be the true theory—is this: Ages ago the Americans presented a very different appearance from what they now do. Then an immense peninsula extended itself from Mexico, Central America, and New Granada, so far into the Atlantic that Madeira, the Azores, and the West India Islands are now fragments of it. This peninsula was a fair and fertile country inhabited by rich and civilised nations, a people versed in the arts of war and civilisation—a country covered with large cities and magnificent palaces; their rulers, according to tradition, reigning not only on the Atlantic Continent, but over islands far and near, even into Europe and Asia. Suddenly, without warning, this whole fair land was engulfed by the sea, in a mighty convulsion of nature.

Now, this catastrophe is not impossible or even improbable. Instances are not wanting of large tracts of land, several hundred miles in extent, disappearing in a like manner. The island of Ferdinandea sudddenly appeared, and after a while as suddenly disappeared. In 1819, during an earthquake in India, an immense tract of land near the River Indus sank from view, and a lake now occupies its place.

The whole bed of the Atlantic, where Atlantis is said to have been situated, consists of extinct volcanoes. The terrible Lisbon earthquake of 1755, and the later American shock, created a commotion throughout the whole Atlantic area.

That Atlantis possessed great facilities for making a sudden exit cannot be doubted. Its very situation gives good colour to the narratives of ancient Grecian historians and Toltecian traditions, that "it disappeared by earthquakes and inundations."

Not only is it within the bounds of possibility that it might have occurred, but if traditions so clear and distinct as to be almost authentic history are to be believed, then it did occur. Listen to what one of the most cautious of ancient writers, Plato, says:—"Among the great deeds of Athens, of which recollection is preserved in our books, there is one that should be placed above all others. Our book tells us that the Athenians destroyed an army that came across the Atlantic Seas, and insolently invaded Europe and Asia, for this sea was then navigable; and beyond the straits where you place the Pillars of Hercules was an immense island, larger than Asia and Libya combined. From this island one could pass easily to the other islands, and from these to the continent beyond. The sea on this side of the straits resembled a harbour with a narrow entrance; but there is a veritable sea, and the land which surrounds it is a veritable continent. On this island of Atlantis there reigned three kings with great and marvellous power. They had under their domain the whole of Atlantis, several of the other islands, and part of the continent. At one time their power extended into Europe as far as Tyrrhenia, and uniting their whole force they sought to destroy our country at a blow, but their defeat stopped the invasion and gave entire freedom to the countries this side of the Pillars of Hercules. Afterward, in one day and one fatal night, there came mighty earthquakes and inundations, that engulfed that warlike people. Atlantis disappeared, and then that sea became inaccessible, on account of the vast quantities of mud that the engulfed island left in its place." It is possible that the *débris* said to have been left by this catastrophe might be identical with, or the nuclei of, the *sargazo* fields that, many centuries later, Columbus found almost impenetrable. Again, Plato, in an extract from Proclus, speaks of an island in the Atlantic whose inhabitants preserved knowledge from their ancestors of a large island in the Atlantic, which had dominion over all other islands of this sea.

Plutarch, in his Life of the philosopher Solon, Herodotus, and other ancient writers, speak of this island as a known fact; and it is impossible to believe otherwise than that Seneca thought of Atlantis when he writes in his tragedy of "Medea"—"Late centuries will appear, when the ocean's veil will lift to open a vast country. New worlds will Thetsys unveil. Ultima Thule" (Iceland) "will not remain the earth's boundary." He evidently believed in the unknown island and continent, and knew it would not remain for ever unknown.

Diodorus Siculus says that "opposite to Africa lies an island which, on account of its magnitude, is worthy to be mentioned. It is several days distant from Africa. It has a fertile soil, many mountains, and not a few plains, unexcelled in their beauty. It is watered by many navigable rivers, and there are to be found estates in abundance adorned with fine buildings." Again he says, "Indeed it appears, on account of the abundance of its charms, as though it were the abode of gods and not of men."

The situation, the description of the country, in fact every particular, agrees precisely with our idea of Atlantis; and what other land now in existence agrees in any way with this description—what islands of magnitude that contain navigable rivers, large fertile plains, and mountains?

Turning from our well-known ancient writers, we find, in all the traditions and books of the ancient Central Americans and Mexicans, a continual recurrence to the fact of an awful catastrophe, similar to that mentioned by Plato and others.

Now, what are we to believe? This, that either the traditions and narratives of these ancient writers and historians of both lands are but a tissue of fabrications, evolved from their own brains, with perhaps a small thread of fact, or else that they are truths, and truths proving that the Americas, instead of being the youngest habitation of man, are among the oldest, if not, as De Bourbourg affirms, the oldest.

Brasseur de Bourbourg, who Baldwin says has studied the monuments, writings, and traditions left by this civilisation more carefully and thoroughly than any man living, is an advocate of this theory, and to him we are indebted for most of our translations of the traditions and histories of the ancient Americans.

To the imaginative and lovers of the marvellous this theory is peculiarly fascinating, and the fact that there is plausible evidence of its truth adds to the effect. With their mind's eye they can see the dreadful events, as recorded by Plato, as in a panorama. They see the fair and fertile country, filled with people, prosperous and happy; the sound of busy life from man and beast fills the air. Comfort and prosperity abound. The sun shines clear overhead, and the huge mountains look down upon the cities and villages at their feet, like a mother upon her babes: all is a picture of peacefulness. Suddenly, in a second, all is changed. The protecting angels become destroying fiends, vomiting fire and liquid hell upon the devoted cities at their feet, burning, scorching, strangling their wretched inhabitants. The earth rocks horribly; palaces, temples, all crashing down, crushing their human victims, flocked together like so many ants. Vast rents open at their very feet, licking with huge flaming tongues the terrified people into their yawning mouths. And then the inundations. Mighty waves sweep over the land. The fierce enemies, Fire and Water, join hands to effect the destruction of a mighty nation.

How they hiss and surge, rattle and seethe! How the steam rises, mingled with the black smoke, looking like a mourning-veil, that it is, and, when that veil is lifted, all is still, the quiet of annihilation! Of all that populous land naught remains save fuming, seething mud. It is not to be supposed that all perished in that calamity. Long before this they had spread over the portion of the Americas contiguous to the peninsula, building cities, palaces, roads, and aqueducts, like those of their native homes; and adventurous pioneers continually spreading north, east, and westward, their constant increase of numbers from their former homes enabling them to overcome the resistance offered to their progress by both natives and nature, till at last they reached and discovered the copper country of Lake Superior. That they appreciated this discovery is evinced by the innumerable evidences of their works and of their skill in discovering the richest and most promising veins. Wherever our miners of the present day go, they find their ancient fellow-craftsmen have been before them, worked the richest veins, and gathered the best copper; and it is supposed that they continued thus till the terrible blotting out of their native country cut short all this, and left this advancing civilisation to wither and die like a vine severed from the parent stem.

Having no further accession to their numbers, and being continually decimated by savages and disease, they slowly retreated before the ever-advancing hordes. Gradually, and contesting every step, as is shown by their numerous defensive works along their path, they were forced back to their cities on this continent that had been spared them from the universal destruction of their country, where the dense and almost impassable forests afforded them their last refuge from their enemies, and where—reduced by war, pestilence, and other causes, to a feeble band—their total extinction was only a matter of time. Such is probably the history of this lost civilisation, and such would have been the history of our civilisation had we in our infant growth been cut off from receiving the nourishment of the mother countries.

Within the last twenty-five years all sciences relating to the past and present of man have been enormously developed. Old, worn-out, useless theories have been discarded, new facts have taken their places, discoveries have followed discoveries, each discovery helping to form, link by link, the chain of human history.

We are beginning to perceive that we are but yet young in the knowledge of human history,—that we have as yet picked up but a bright pebble of thought or glittering shell of theory, while before us lies the whole vast sea of human history unexplored. That we are beginning to acknowledge this is a good sign, for, when a man or mankind acknowledge their ignorance, they have at least a sure foundation to build upon.

Again, the spirit of bigotry—the spirit that told men to scorn and deride Galileo and Columbus—is fast passing away, and in its stead comes the spirit of rationality, a spirit that tells men to look upon a new idea or theory, even if it does run outside of the accustomed rut, with a reasoning if not favourable eye. And we have faith, as science grows to grander proportions and dispels some of the mist that now envelopes it, that some day not far distant will bring forward an historic Edison that shall bring together the faint voice of the prehistoric past and the bright clear voice of the present; that some future Champollion will discover, among the ruined cities of the Americas, an American Rosetta-stone that will complete the chain of human history. "The noblest study of mankind is man."—*The Popular Science Monthly*.

NOTICES OF BOOKS.

Spon's Encyclopædia of the Industrial Arts, Manufactures, and Commercial Products. Edited by G. G. ANDRE, F.G.S. Division I. London: E. and F. N. Spon.

WE have here the first section of what promises to be a voluminous, but at the same time a useful work. The arrangement adopted is to some extent like that of Muspratt's "Dictionary of Chemistry,"—that is, we have a series of what might almost be called distinct treatises arranged in alphabetical order. Thus the first half of the present volume is devoted to acids, from the acetic to the tartaric inclusive, the sulphuric being, however, placed before the hydrochloric, nitric, oxalic, &c. Such groupings will render a good index absolutely necessary for purposes of reference. In the meantime it is difficult to say whether certain substances are duly dealt with or not, since, if not found in what would seem their natural place, they may turn up afterwards under some general heading. This is the possible reason for the omission of the arsenic, phosphoric, &c., acids, under the section "Acids."

Under the head "Carbolic Acid" we find mention of a curious fact, biological rather than technological, but well worth putting on record. Even very brief contact of the strong acid with any considerable surface of the lower part of the body is usually fatal, whilst the arms and upper parts may be thus wetted with comparative impunity. "In one instance a man employed at a carbolic acid works, who often had his entire arms covered with the acid, died from the effects of some of the same acid spilt upon his leg." The enquiry is at once here suggested whether this fact is unique, or whether the same rule applies to any other poisonous agencies.

Picric acid is described under its elder synonym, carbazotic acid, the modern scientific name—trinitrophenol—not being given. A full list of the synonyms of every substance is, we think, greatly to be desired in a work like the present.

In treating of arsenic the authors inform us that its price is ruled to a great extent by "rings." In the first six months of 1878 a combination of merchants drove up the price from £7 to £12 per ton in three weeks, all surplus stocks being got rid of by consignment to the United States. "The combination, however, broke down, and the price fell, almost as rapidly as it had risen, to £8 per ton. Such combinations are readily carried out, because the make is small—only about 8000 tons per annum—and is in very few hands." The supply being so limited it may perhaps be deemed singular that, in addition to its more legitimate uses, arsenic should crop up as it does in "violet powder," and even in French chalk, as has recently happened with tragic result. Such being the case we trust that the authors are mistaken when they say "there is reason to believe that it (the manufacture of arsenious acid) has yet to see its best days both in this country and on the Continent." On the contrary, it seems to us that, in deference to public opinion, very stringent regulations will be adopted at home and abroad concerning the industrial use of arsenical compounds.

In the notice of asphalte, as applied to road-making purposes, we find another interesting case, showing how industrial operations are often frustrated by the operations of speculators. "As often happens to new industrial schemes carried on on so gigantic a scale, it fell into the hands of speculators whose main object was not the successful working of the mine," but gambling in shares. "A ring was formed, which in a few months raised the price of the shares from 500 to 13,000 francs. This did not last, and in a short time the 13,000 franc shares were being offered at 25 francs each. Asphalte, however, was destined to overcome these difficulties, and, though it remained some time in the hands of speculators, it eventually took its proper place as an important and profitable industry."

Under the section on hydrochloric acid we find a somewhat elaborate notice of the noxious vapours question, including the chief provisions of the Supplementary Alkali Act of 1874 (37 and 38 Vict., cap. 43) and the somewhat formidable "recommendations" of the Commission which has recently completed its labours. The definition of the term "noxious gas," in the above-mentioned statute, borders upon the facetious. It is made to include sulphurous acid *except* that arising from the combustion of coals." This is the old—we cannot say good—rule; punish the small offender, and let the great sinner go free.

The recommendations sin by default in overlooking the relative fitness of places. One code is to be laid down for all parts of the kingdom. Any man who should erect an alkali works, say in the Isle of Wight or on the banks of Derwentwater, would encounter no more stringent regulations than if he had gone to work in South Lancashire, in the Black Country, or in the outskirts of Glasgow. We would "recommend," on the contrary, the absolute prohibition, in certain districts, of all works capable of generating nuisances, whether solid, liquid, or gaseous, and in other districts the concession of very great latitude.

It is of course somewhat premature to pass judgment upon a work of which so small a portion only has appeared. It seems to us, however, that whilst the arrangement leaves something to be desired, the matter may upon the whole be pronounced valuable. Most readers will be able to find here useful information for which they might have elsewhere to make a long and tedious search.

Elementary Lessons on Sound. By Dr. W. H. STONE. London: Macmillan and Co.

THE purpose of this little work, as the author informs us, is to "furnish information intermediate between Acoustics and Music proper, supplementary to both"—a task which appears to be fairly fulfilled. In addition, and we suppose as a matter of course in the present day, it gives "a concise outline of subjects required for examination.

Papers, Proceedings, and Report of the Royal Society of Tasmania for 1877. Tasmania: Mercury Steam-Press Office, Hobart Town.

THE Royal Society of Tasmania is active, and is doing the right kind of work,—that is, work which can be better done in Tasmania than in any other part of the world. One point, however, we cannot help noticing with regret. Of the eleven papers published, seven—and certainly not the least valuable—are due to two of the Fellows of the Society, the Revs. J. E. Tenison-Woods and W. W. Spicer. The death or removal of either of these gentlemen would leave the Society, judging from present appearances, in a very unsatisfactory condition. We have great pleasure in putting on record the active and useful part played by the Governor and the Bishop.

One of Mr. Spicer's papers, "Plants as Insect-Destroyers," gives a very complete summary of phenomena not generally known. The fungoid genus *Cordiceps*, the species of which are parasitical on various beetles, wasps, and moths, is particularly described. Among unscientific observers the opinion still prevails that the insect, which of course ultimately perishes, is being gradually metamorphosed into a plant. There is, however, a rumour that a phanerogamous plant springs, in an apparently similar manner, from the decaying body of an insect. According to M. le Compte d'Ursel, during his travels in various parts of South America he met with an insect which he describes and figures as a thick, distinctly articulated grub, hard to the touch. When about to die it buries itself some centimetres deep in the earth, and expands till it assumes the appearance of a potato, though still retaining its original shape. A stem is then produced, which shoots up and bears a crop of blue flowers. The author admits that the origin of the plant may be a seed contained in the body of the insect, but he evidently leans to the theory of direct metamorphosis. We wish this insect would have presented itself to Mr. Wallace or Mr. Bates during their abode in South America, so that this strange phenomenon might have been thoroughly examined. The discoverer does not seem to be either a botanist or an entomologist.

A paper on "New Britain and New Ireland," by the Rev. G. Brown, contains some interesting facts in animal geography. Thus the cuscus is found in New Guinea and New Ireland, but not in the intervening island of New Britain. The wallaby has hitherto been found in New Ireland alone. The only marsupial obtained in New Britain was a small flying squirrel. Strange reports had reached Mr. Brown of a race of men with tails said to live in the interior of New Britain. In consequence he arranged an expedition to the locality. Unfortunately one of the party, a sailor, got access to a bottle of gin, and was the cause of so serious an accident that the party had to return to the ship with the wounded man, and circumstances did not allow of a second attempt. This disappointment is the more to be regretted as the discovery of an ape in the islands south-eastward of New Guinea would have been hardly less interesting than the occurrence of tailed men.

In the discussion following upon the reading of a paper by the Rev. W. W. Spicer, on the "Foreign Plants which have been naturalised in Tasmania," particular mention was made of the blackberry and sweet briar, both of which thrive in Tasmania with a luxuriance quite unparalleled in England. The question was raised whether birds ever feed upon the blackberry or raspberry. With Mr. Spicer we think that they do not in Europe, but we are by no means certain.

The same author, in an interesting paper on "Silk and Silk-Producers," gives a satirical account of the medicinal uses to which insects were formerly put. Thus the yellow matter which exudes from the joints of the bilbeetle [? oil-beetle, genera *Proscarabæus* and *Meloe*] was held to be as efficacious in dropsy or rheumatism as in hydrophobia, and no doubt was so." That many of the medicinal virtues ascribed to insects were merely imaginary may well be admitted, but we must guard against supposing that if taken internally they would prove inert. The yellow matter above mentioned would very probably be found rich in cantharidin.

Mr. Morton Allport contributes a paper on the "Acclimatisation of Salmon in Tasmania." He appears to take a hopeful view of the results of the experiment. It may be mentioned that amongst the fishes found off the coasts some are absolutely identical with well-known inhabitants of the British seas, such as the conger, the sprat, the horse-mackerel and the John Dorey.

We trust that the Royal Society of Tasmania will persevere in the course that it has evidently taken, working out the biology, geology, mineralogy, and climatology of the island.

Colour-Blindness: its Dangers and its Detection. By B. Joy Jeffries, M.D. Boston: Houghton, Osgood, and Co. London: Trübner and Co.

Dr. Jeffries had, it appears, originally intended to produce an English version of the work of Prof. Holmgren, "Colour-Blindness and its Relations to Railroads and the Marine." Being, however, anticipated by an abridged translation which appeared in the Reports of the Smithsonian Institute, he was led to draw up an independent treatise, covering, however, essentially the same ground. It must therefore be distinctly understood that the present volume is not, and does not profess to be, an exhaustive monograph of colour-blindness. The author's aim is essentially practical. He seeks to point out the dangers to life and property which may arise from the employment on railways or on shipboard of men defective in the colour-sense, and to explain in detail the best means for their detection. These dangers are undoubtedly real and serious. If one out of every twenty-five of the male population of civilised Europe and America is more or less unable to distinguish colours,—a truth which appears established,—there is a certain element of probability that the engine-driver or the look-out man, upon whose judgment our personal safety depends, may mistake the colour of a signal and rush headlong to his own and our destruction.

The more speculative, and to many men of Science the more interesting, phase of the subject, is but slightly touched upon. Little new light is thrown upon the ultimate causes of colour-blindness; upon the laws of its production by accident, disease, or immoderate narcotism; upon the *rationale* of its predominating frequency in the male sex, its relative occurrence in different races and nations, and its possible extension among the lower animals. The comparative delicacy of the colour-sense among the two sexes in birds, &c., becomes a very important point. If, as among mankind, the females are the most sensitive to colour, whilst the males are admittedly the most highly coloured, we have a strong confirmation of the hypothesis of sexual selection.

Nor does Dr. Jeffries discuss the alleged recent development of the colour-sense, nor the influence which its varying degrees of perfection may have upon decorative art or upon personal ornamentation in different ages and in different nations. It would be, however, highly unfair to blame him for omitting subjects which he has intentionally excluded from his plan. What he has undertaken he has executed thoroughly and satisfactorily, and his work is hence an invaluable manual for the higher officials of railways, for the authorities of the navy, and for the proprietors of trading- and passenger-vessels. All such persons will here find what, in this respect, is their duty to the public, and how it may best be performed. To the medical profession it will prove an indispensable guide in the examination of supposed cases of colour-blindness.

The Music of the Bible; with an account of the Development of Modern Musical Instruments from Ancient Types. By JOHN STAINER, M.A., Mus. Doc., Magd. Coll., Oxon. London: Novello, Ewer, and Co., and Cassell, Petter, and Galpin.

THE author of this little book has carefully weighed the abundant though discordant evidences as to the identity of biblical musical instruments. The many sieges which Jerusalem has undergone have destroyed every monumental trace; a few coins are the only Hebrew source of information. Fortunately nations with whom the Jews were in constant intercourse, the Egyptians and Assyrians, supply abundance of material for the determination of the musical instruments in use by them, which may fairly be considered to have greatly influenced the musical resources of the Hebrews.

With respect to the origin of stringed instruments, Dr. Stainer is of opinion that the common hunting-bow is the parent of the whole family; and the series on page 72 show how easily the violin, guitar, dulcimer, and even the pianoforte itself, may have been evolved by a progressive series of alterations. Indeed the comparative anatomy, if it may be so called, of musical instruments seems to have been diligently studied by the author in his endeavour to show the probable nature of the resources of the Jewish orchestra. That the instruments varied at different periods of their history there can be little doubt. For instance, at page 97, Dr. Stainer remarks, "We have the same name (organ) for the single row of about fifty pipes, placed perhaps in a little room, and the mighty instrument of five thousand pipes, occupying as much space as an ordinary dwelling-house, and requiring the daily attention of a qualified workman to keep its marvellous complications properly adjusted; yet each is an organ. May it not have been the case that the '*ugab*,' which in Gen. iv., 21, is mentioned as the simply constructed *wind* instrument, in contrast to the simple *stringed* instrument, the '*kinnor,*' was a greatly inferior instrument to that which in Ps. cl. is thought worthy of mention by the side of a term for the whole string power." It is only natural to suppose that instruments bearing the same name must have been greatly improved in the course of two thousand years or more.

The modern bell is shown (p. 142) to have been derived by a simple succession of developmental changes from the cymbal. The bell of ancient times could hardly be looked upon as a musical instrument, but was a mere ornamental appendage,—either little cymbals like the jingles on the modern tambourine, or like toy bells placed on dog-collars, &c. The bell proper appears not to have existed until the Middle Ages, and to have originated in Europe.

The last chapter is devoted to the consideration of Jewish vocal music: here the accents appended to the Hebrew text furnish some evidence, but explanations are conflicting, and modern traditions among the Jews of little value.

Dr. Stainer certainly deserves the thanks of musicians, as well as of biblical students, for his painstaking and elaborate researches on one of the most difficult subjects within the range of Archæology.

CORRESPONDENCE.

HEREDITY.

To the Editor of the Monthly Journal of Science.

SIR,—Your article on "The Criminal Law of the Future" is very interesting, and doubtless true; although if Oliver Cromwell had known of it he would probably have said that he had been a fool to stop short with only massacreing the inhabitants of Drogheda, in Ireland, and that Irish proclivities to murder and rebellion "proves only the more convincingly the necessity for their elimination" (p. 594). Furthermore, it would warrant the extermination of Zulus and other tribes.

But the question which struck me was, how is it that the principle of Heredity does not apply to genius? The learned Count de Maistre remarked of France—"A considerable portion of the literary glory of the French, particularly in the great century, belongs to the clergy. Science being generally contrary to the propagation of families and of names. Hence arises the ancient prejudice as to the incompatibility of science with nobility—a prejudice founded, like all prejudices, on some hidden cause. No learned man of the first class has been able to found a house. Already even the names of the sixteenth century that were celebrated in literature and science no longer exist."—I am, &c.,

WILLIS NEVINS.

Cheltenham.

SEA-SERPENTS.

To the Editor of the Monthly Journal of Science.

SIR,—Several alleged appearances of large sea-serpents have been lately recorded, but unfortunately they leave the question of the existence of such creatures precisely where it was. The being which struck and sunk the Norwegian barque *Columbia*, on September 4th, is described as "a fish or some other sea-monster," and may probably have been a large whale. The creature seen by Captain J. F. Cox, of the *Privateer*, on August 5th, must have been a large ophidian if his description is trustworthy. But he will probably be at once proclaimed unworthy of credit. We are by no means sure that if such a serpent had been seen by the entire scientific staff of the *Challenger* their united testimony would have been accepted.—I am, &c.,

Serpent-Hunter.

THE ENDOWMENT OF RESEARCH.

To the Editor of the Monthly Journal of Science.

Sir,—In the able Address delivered by Dr. Pye-Smith, in the Anatomical and Physiological Department, Section D, of the British Association, as reported in your October number, there is one passage which seems to require comment. The learned speaker declared that he "should be sorry to see the endowment of research in biology," and it is to be presumed in other sciences also, "undertaken by Government funds." But those who advocate the endowment of research for the most part make no demands upon Government funds. They urge, first, that the present endowment of "cram" should cease, and that the positions and emoluments now handed over to successful examinees should be conferred upon discoverers; secondly, they demand that the fellowships of our old national universities should be made, as they were intended by their founders, the incentives and the rewards of original thought and research." "Local energy and unofficial zeal" have indeed done great things for England; but what have they done in this particular sphere? What would they even be permitted to do? Suppose a number of wealthy gentlemen agreed to found and endow a college where the highest honours should be attainable by research alone, would it receive official recognition and be permitted to grant any kind of degrees? We think not.—I am, &c.,

Scrutator.

NOTES

BIOLOGY.

In a communication to the Academy of Sciences, M. L. Vaillant remarks that the fecundity of axolots being no longer contested, we are compelled to regard them not as a pathological modification,—an opinion still admitted by certain foreign *savants*,—but as a normal metamorphosis conformable to the cycle habitually known among the *Urodeles*. These animals, under certain conditions not yet determined, appear to reproduce themselves in two states—as larvæ and when completely developed. This is a fact not unexampled among the inferior Vertebrates and certain Articulates, as remarked by M. Blanchard in 1868 (*see* "Comptes Rendus de la Reunion de la Soc. Helvetique").

M. Galtier has undertaken a series of experimental studies on rabies, and has recorded the results in the "Comptes Rendus." He finds that rabies may be transferred from the dog to the rabbit, and from one rabbit to another, the predominant symptoms being paralysis and convulsions. It is impossible to say whether the virus of the rabbit has the same intensity of action as that of the dog. The period of "incubation" in the rabbit is shorter than in other animals, not exceeding eighteen days. Salicylic acid injected hypodermically every day for a fortnight, beginning with the fiftieth hour after inoculation, has not been found to interfere with the development of the disease. The saliva of a mad dog, taken from the living animal and kept in water, retains its virulence for twenty-four hours. (It is often asserted that the deaths of human subjects after being bitten by a rabid dog, ascribed to hydrophobia, are really due to a morbid imagination. We wonder if this plea will serve to explain the deaths of the rabbits experimented upon as above.)

According to MM. Callol de Poncy and Ch. Livon, in cases of chronic arsenical poisoning this element takes the place of the phosphorus normally present in the lecithin in the form of phospho-glyceric acid.

Prof. Balbiani gives an account, in "Leçons sur la Génération des Vertébrés," of the embryogenous cellule or vesicule which has been detected by many observers in the ova of various animal groups, vertebrate and invertebrate. He considers it as analogous to a seminal cellule which must exert upon the ovum an action similar to that of a spermatozoid. In many animals, it must be remembered, these elements have not the filamental form and are devoid of mobility. This is the case with most of the Crustaceans, with the chilognathic Myriapods, the nematoid worms, &c. The germ in the female ovule is formed under the influence of a sort of fecundation exercised by this embryogenous cellule which represents the male element. It is always around this element that the plastic granulations are deposited. This cellule being a primordial male element, we understand that, with certain beings and in certain cases, its action is not limited to the formation of the germ. It may determine, in a manner more or less complete, either merely the first phases of the development of the ovum or even this development in its entirety, producing a perfect animal which constitutes parthenogenesis. Known facts prove that in various animal species—even Vertebrates—unfecundated eggs have undergone a more or less complete development, which, however, in no vertebrate species has been found to lead to the development of a perfect animal. Among Invertebrates—such as certain Lepidoptera and Hymenoptera (*Cynips*, species)—parthenogenesis is far from uncommon, and among the Aphides it has become the rule rather than the exception.

An account of the Cephalic Ganglia of Insects has been presented to the Academy of Sciences by M. N. Wagner. The sub-œsophagian ganglion governs principally the appendages of the mouth, and differs little in its histological structure from the other nuclei of the ganglionic chain. As for the cerebroid or super-œsophagian ganglia, they are the seat of nearly all the functions of the brain among the Vertebrates. Here are the organs of perception, of memory, intelligence, &c. Hence the histological structure is more complicated. Towards the centre of the ganglion are found three groups of small cellules, disposed in stages one above another. The greater or less development of these parts of the nervous system coincides with the intellectual development, and is more manifest in the working ants and bees than in the queens, and still more in the males where there exist mere rudiments of these organs.

M. Bacchi has examined the action of sodium phenate in the treatment of bacterihæmic disease. A drop of blood from a frog which had perished of this disease was injected under the skin of each of two healthy frogs. A day or two afterwards phenate of soda was injected under the skin of one, whilst the other remained without treatment. The former in every case recovered, whilst the latter died of bacterian blood-disease.

M. J. Renaut recommends for histological uses a solution of eosin and hæmatoxylin mixed with glycerin. He places in a test-glass 1 part by measure of neutral glycerin and the same volume of a saturated solution of eosin (aqueous or alcoholic), and then drops in hæmatoxylin prepared according to Boehmer's formula, until the green fluorescence becomes almost imperceptible. The violet liquid is then filtered. Its action is found very satisfactory.

According to M. Jolly the iron present in the blood globules exists exclusively in the state of phosphate.

MM. Marat and Ortille have observed that in uræmia the respiratory power of the blood is not strikingly changed until death is imminent. The respective proportions of oxygen and carbonic acid present in the arterial blood is also little altered. Ammonium carbonate is detected in the stomach, and ultimately in the blood also.

At a meeting of the Anthropological Society of Paris, M. Broca gave an account of certain observations made with a young Barbary ape. If shown an uncoloured likeness of any ape it at once gave signs of recognition. On seeing the coloured picture of a Macacus it attempted to search for fleas—the usual mark of friendship among apes. Before the figure of an orang-outang, whether plain or coloured, it expressed at once fear and curiosity; and before that of a sloth, irritation.

M. Dareste has in some instances found the amnios entirely wanting in embryo chickens.

M. Vulpian has been examining the action of certain "heart-poisons" upon the escargot (*Helix pomatia*). The alcoholic extract of the seeds of *Strophantus hispidus* and *muscarin* arrested the action of the heart in this snail in manner analogous to what is observed in frogs and mammiferous animals. Upon the heart of Crustaceans neither of these substances produced any perceptible effect.

The influence of a change of climate upon plants is pointed out by MM. Naudin, of Collioure (Pyrenées Orientales), and Radlkofer, of the Botanical Gardens, Munich, who have carried out a joint series of experiments on this subject. The mean annual temperature of the former station is 14·9°; that of the latter only 5·79°. They conclude that the more northern origin of a seed does not necessarily imply greater precocity in the resulting plant than if it had ripened in a warmer climate, inferences deduced from observations on cereals not being generally applicable. Seeds from a warmer locality may grow more rapidly and strongly in one and the same climate than those obtained from a colder source, as *Sonchus oleraceus*, *Solanum nigrum*, &c. In others, as *Calendula arvensis*, *Malva rotundifolia*, &c., the converse holds good.

Dr. Bureau has communicated to the Zoological Society of France a set of plates showing the transformations of the beak of certain birds of the family Mormonides. The beak has hitherto been considered an organ available for the demarcation of genera. The author, however, has shown that after the breeding season the beak of *Fratercula arctica* falls off in nine portions. Hence this species has two forms of beak—one in winter, small, and covered at the base with a membrane; the other in summer, thick, large, robust, horny, and trowel-shaped; marvellously well adapted for digging the burrows in which this bird nests. A similar phenomenon is observed in all the birds of the North Pacific comprised in the genera *Fratercula*, *Lunda*, *Sagmatorrhina*, *Ceratorhynca*, and *Simorhyncus*. Hence many species which have been founded merely on the form of the beak will require revision.

MM. Couty and De Lacerda have made a series of experiments on the poison of the Brazilian serpent (*Bothrops jararacussu*). The animals bitten or inoculated with the poison, whether in its natural state or diluted with water, all perished in from two to ten minutes. The first action perceived was one of excitement, variable in its seat, as if the action of the poison was localised sometimes in one organ and sometimes in another. Death was always preceded by a complete paralysis of the brain and spinal chord, with relaxation of the limbs and acceleration of the heart.

M. J. Lichtenstein has carefully studied the metamorphoses of *Lytta vesicatoria* (the Spanish fly), which are exceedingly curious. The larva—like those of the nearly allied genera *Meloe*, *Sitaris*, and *Epicanta*—is piratical, infesting the nests of certain earth-bees, such as *Halictus* and *Andrena*, preying first on the eggs and young larvæ, and afterwards on the store of honey.

According to the very decided testimony of a Persian now resident in Paris, fair-haired persons are not unknown in his country.

M. Percy has communicated to the Société des Sciences Physiques et Naturelles de Bordeaux, a paper on the effects of the parasitism of the *Stylops* upon bees of the genus *Andrena*. Certain species of this genus were formerly supposed to be invariably beset with this parasite, but on closer examination the author discovered that they were merely abnormal forms of other species modified by the presence of the *Stylops*. In *Andrenæ* thus attacked each sex loses more or less its characteristic structure and colouration, and tends to acquire those of the opposite. In a Stylopised female *Andrena* the ovarian tubes are completely arrested in their development, inducing complete sterility. In the male a similar atrophy is confined to one side. These results are merely due to the pressure caused by the presence of the parasite.

A paper on the "Mutual Influence of Graft and Stock" is given in the "Zeitung für Land wirthe" (1878, No. 62, p. 353). E. A. Carrière grafted tomatoes upon common nightshade (*Solanum dulcamara*). Many of the plants reached the height of 3 metres, and yielded abundant fruit, differing little in appearance from the ordinary kind, but much sweeter and containing fewer seeds. Jerusalem artichokes grafted upon the sunflower attained a gigantic height, whilst the roots of the stock in two places had developed tubers something like those of the dahlia.

At one of the last sittings of the Academy of Medicine Dr. Jollivet reported that sixteen persons, in the Department of Seine et Oise, have been seriously attacked with trichinosis. This is the first outbreak of the disease in France.

M. Fredericq has continued his researches on the blood of the octopus and the lobster. That of the former contains merely a single albuminoid species, the two great functions of the blood, respiration and nutrition, devolving upon one and the same chemical compound, hæmocyanin. In the blood of the lobster, in addition to the blue colouring matter, hæmocyanin, there is found a rose coloured principle, soluble in alcohol. The blood of certain Gasteropods contains hæmocyanin, but it is not found in that of the Lamellibranchiæ.

Among the Primates the olfactory apparatus, the great limbic lobe, loses its importance. Among the apes there exists always a slight furrow, which extends as far as the fissure of Sylvius. M. Broca formerly considered this limbic furrow as characteristic of the apes, but he has subsequently detected it in all the brains belonging to the lower human races which he has been able to examine.

Abrassin oil is, according to the "Œst. Landwith. Wochenblatt," obtained in China from the seeds of *Elæococca cordata*, and is said to be an excellent protective against noxious insects. The tree, which belongs to the family of the Euphorbiaceæ, prospers in the South of France, where its culture is recommended, in the hope of the oil proving a specific for the *Phylloxera* and the *Oidium*.

The influence of quinine upon silkworms has been satisfactorily proved by C. Le Doux. Broods of caterpillars suffering from *flacquerie* were speedily restored by sprinkling their food with quinine sulphate. The same treatment proved successful in cases of "pebrine" with open wounds.

Cases of poisoning by caterpillars have been observed both in cows and ducks. The former experienced gastric symptoms, diarrhœa, loss of appetite, &c., but were all restored by means of mucilaginous drinks and a diet of boiled potatoes and bran. Ninety ducks were turned into a cabbage-field infested with the caterpillars of the common white (*Pieris brassicæ*). In one afternoon the field was almost clear, but two ducks died after an hour. The next morning twenty were found dead, and altogether fifty-three perished. The flesh of the dead, on examination, was found to resemble that of cattle which die of gangrene, indicating true poisoning.

CHEMISTRY AND TECHNOLOGY.

In the International Exhibition, now being held at Sydney, a collection of soils, manures, and agricultural products is shown by the Imperial College of Agriculture in Tokio, Japan. Accompanying the collection is a descriptive catalogue, compiled by Mr. Kinch, the Professor of Chemistry at the College, in which a short account is given of the various products exhibited, with about eighty chemical analyses. The catalogue opens with some analyses of soil. Then follow analyses of manures, including lime, wood ashes, nitre, waste vegetable substances, and residues from various manufactures, fish manure, bone, superphosphate, birds' dung, and hair. Next in order come analyses of foods. Then a summary of the dye-stuffs, and also of the various oils and resins.

In a paper on "Measures for Disinfecting," read at a Meeting of the German Public Health Association, at Stuttgart, reported in the "Sanitary Record," Prof. Hofmann said that disinfection can only be said to have been carried out when the following conditions have been fulfilled ;—(*a.*) By considering the object or poisonous germ which is to be destroyed. (*b.*) By considering the place or object where the poisonous germs may be found or must exist. (*c.*) By a thorough knowledge of the mode of action and the qualities of the disinfectant that is being used.

At the Manchester Meeting of the Social Science Congress Mr. C. T. Kingzett read a paper on "The Eucalyptus and the Pine considered in relation to their Sanitary Properties." The action of the eucalyptus is stated to be of a positive type, and, like the pine tree, its properties are of a healthful nature, upon whatever soil or in whatever climate it may grow. The *Eucalyptus amygdalina* is the most abundant oil-giving tree, 100 lbs. of the leaves giving from 3 to 6 lbs. of the oil. This oil is practically identical in composition with the oil of turpentine derived from pine trees, and with most of the so-called essential oils or perfumes. By the investigations of Mr. Kingzett it has been ascertained that all these oils, when subjected to the action of atmospheric oxygen and moisture, produce peroxide of hydrogen and a number of camphoraceous substances having marked antiseptic powers. Taking New South Wales and South Australia alone, Mr. Kingzett calculates that the eucalyptus forests contain at any given moment sufficient oil in the leaves to form by contact with the atmosphere no less than 92,785,023 tons of pure peroxide of hydrogen, and 507,587,945 tons of camphoraceous principles. If it be remembered that in Nature all matters of animal and vegetable origin are oxidised by the atmosphere, which is thus kept free from the pernicious products of putrefaction, and that peroxide of hydrogen is a much more powerful oxidant than ordinary oxygen, and if it be also borne in mind that the camphoraceous products above referred to are also powerful antiseptic agents, then the healthful influences of the eucalyptus can neither be wondered at nor be longer open to any doubt. What is true of the eucalyptus is also true of the pine, and on an immensely larger scale; and the oil of turpentine, which is a natural product of these trees, undergoes the same chemical changes in the atmosphere as oil of eucalyptus. By imitating this natural process of oxidation, Mr. Kingzett has, as is well known, succeeded in obtaining and rendering available in commerce the antiseptic and oxidising principles to which pine and eucalyptus forests owe their hygienic influences.

The adulteration of olive oil has become so prevalent that the Minister of Agriculture and Commerce has requested the Academy of Sciences to ascertain the most trustworthy method for the detection of such frauds. Among the procedures at present under examination by a special committeee is the use of the diagometer, an instrument devised by Prof. Luigi Palmieri, founded on the difference of the electric conductivity of oils. Seed oils are as a class better conductors than olive oil. At the same time every oil conducts the better the greater are its impurities. Linseed and cotton seed oil are among the best conductors, whilst the oils of pine seeds and of hazel nuts are almost as feebly conductive as the purest olive oil, known in commerce as virgin oil. Fortunately these two oils are too rare and costly to be used in the adulteration of olive oil. The use of the diagometer requires considerable manipulative skill.

At a recent meeting of the Berlin Dyer's Association the new colour, "Puteaux blue," manufactured by MM. Patry, of Puteaux, came under discussion. It was considered to be in all probability an indulin, but was pronounced not well adapted for wool-dyeing. For mixed colours upon silks, and as a ground for blues, it was said to be applicable. Dr. Reimann, in speaking of "pittacall blue," considered that at no very distant period the products of beech tar would be utilised for the production of artificial tannin.

The system of "weighting" of silks is, remarks M. Marius Moyret, ruinous to the silk-growing departments of France. Their high-class products are no longer in demand, as inferior and cheaper foreign silks serve equally well for loaded tissues. Hence these districts, already suffering from the *Phylloxera* and from the loss of the madder trade, are in the utmost distress. The author proposes that in the sale of silks, as in that of gold and silver, the proportions of the real article and of weighting matters should be exactly specified, and that a central office for the cheap and rapid assay of silks should be opened in Lyon. He states that the most excessive weighting has been carried out by a New York firm.

In connection with the general Congress of German Apothecaries, held at Hanover on September 4, was exhibited a collection of pharmaceutical antiquities, including a specimen of genuine oriental bezoar, a goblet of metallic antimony, formerly used for imparting a purgative effect to wine or beer, a venerable sample of " Album Græcum," a selection of chemical apparatus inscribed with alchymistic symbols, a gaily-adorned jar for containing " Mithridate," &c.

Instead of linseed-meal as a lute for distillatory apparatus, Thanisch proposes the use of strips of brown paper smeared over with bookbinders' paste to which one-eighth of glycerin has been added.

The chemical purification of waste waters has been studied by Jean de Mollins. The author, who has dealt with the waste waters from the woollen mills of Roubaix, recommends milk of lime and sulphate of alumina, together or separately. He considers that the action of the aluminous hydrate upon the organic impurities of water is quite analogous to its behaviour with dissolved colouring-matters which it throws down in the form of lakes. He also points out that clay, if diffused in water, becomes coagulated by the presence of certain salts, and carries the organic impurities down with it.

A new method of producing varnish is proposed by Dr. E. Schrader. He causes ozone to act upon linseed oil: it is at once perfectly bleached and brought to the proper consistence without the aid of fire.

From a report by M. de Luynes (Société d'Encouragement pour l'Industrie Nationale) on M. C. Lorilleux's manufacture of printing and lithographic inks, we find that two kinds of varnish are employed in the manufacture of printing inks ; the one obtained by boiling linseed oils, and the other from a mixture of resin and resin oil, the latter being chiefly used for newspapers where rapid drying is of importance. M. Lorilleux allows his linseed oil to rest for two years at a constant temperature. It is then boiled by means of hot air, at a distance from the furnaces so as to remove every risk of fire. A mass of 2500 kilos. is boiled from twenty-four to fifty-six hours, and is stirred by a mechanical agitator. The varnish thus obtained is limpid and flows well. The lamp-black is produced either by means of specially constructed lamps or by the decomposition of naphthalin oils, which fall by drops into a heated retort. The gaseous products are carried off by tubes, at the end of which they are burnt under sheet-iron bells, whilst the black is carried off by a current of air into large chambers. It is afterwards submitted to calcination. All the inks, lithographic or typographic, are submitted to a practical trial before being sent out.

Some researches on damage to the soil and the crops by the waste waters and the gases from manufactures have been instituted by Dr. J. König. These researches relate, in the first place, to the waters from certain mines of zinc-blende in Westphalia, which pass into certain streams used for irrigation, and seriously injure the productiveness of the soil. The presence of zinc oxide in the earth is indicated by the presence of *Viola calaminaria*, which contains in its ash as much as 21 per cent zinc oxide. The author has likewise examined the waste waters from a dye works, a wire works, and from pyrites washing. The two latter he considers as directly poisonous to plants on account of their percentage of ferrous sulphate. The dye water may, by reason of the organic matters which it holds in solution or suspension, gradually overload the soil with humus, and render it boggy.

M. de la Bastie is said to have made great improvements both in the method of tempering glass and in the quality of the product. Among the articles shown to the French Société d'Encouragement are mortars with their pestles for chemical use. At the Liverpool Meeting of the Iron and Steel Institute Mr. C. Wood described the process of Mr. Frederick Siemens, of Dresden, for the employment of toughened glass for sleepers and chairs for railways and tramways. Mr. Siemens tempers and moulds the glass into various forms to suit the different requirements. The cooling of the glass is so regulated that the radiation from each point of the surface corresponds to the thickness of the glass, thus enabling the casting to be equally affected throughout when undergoing the tempering or hardening process. The regulation of the radiation or absorption of the heat in the thicker parts of the casting is done by having hollow iron moulds, and by circulating cold water or cool air at those points where the glass is thickest, so that the casting cools equally all over. The toughened glass is found to be almost as strong as iron, and it possesses greater durability. Mr. Bucknall, C.E., proposes to make the sleepers out of blast-furnace slag, under Mr. Buckley Bullan's process combined with the toughening process of Mr. Siemens.

At the Meeting of the Academy of Sciences on October 13th, M. Berthelot explained the plan of his new work "Essay on Chemical Mechanics founded upon Thermo-Chemistry." The first volume of this work is devoted to calorimetry. The second volume comprises the general study of chemical composition and decomposition. The remainder of the work is devoted to chemical statics.

A new manure is proposed by M. de Molon. Finely-ground phosphate of lime is mixed with sea-weeds, especially varec, the mass being allowed to ferment for six to eight weeks.

A statement is quoted in "Les Mondes" of October 2nd, from the New York "Popular Science Monthly," that a Boston chemist found in a sample of cream of tartar 75 per cent of *terra* *alba*, and that at Chicago, a chemist, in want of antimony sulphide, could find in the shops merely marble-dust blackened with soot.

METALLURGY, MINERALOGY, MINING, &C

In a recent report of the proceedings of the Manchester Literary and Philosophical Society there is a description, by Charles A. Burghardt, Ph.D., of a precious garnet (almandine) from Ramsbottom, Lancashire. Dr. Burghardt was asked to examine certain red granules present in a small specimen of rock, in order to ascertain whether they were garnets or not. The rock itself is a conglomerate of milky quartz grains, cemented together with silica and calcium carbonate; and disseminated throughout this conglomerate are the garnet grains in question, the whole constituting a 14-feet "fault" in the coal-seam known as the Sand-rock or Feather-edge Seam in the "Shipperbottom Mine," near Grant's Tower at Ramsbottom. A microscopical examination of the rock showed the garnets to be very irregular in form and to vary considerably in size, the largest attaining a width of about 2·25 m.m., and the smallest about 0·75 m.m. Both the garnets and the quartz grains could be extracted from the matrix, a cast of their forms being left behind. The red grains fused easily and quietly before the blowpipe to a black bead, which was not, however, magnetic: they were somewhat attacked by hydrochloric acid, with a slight separation of powdery silica; the presence of iron was also detected. The hardness of the mineral was 7·5, and its specific gravity 4·09 at 9° C. Dr. Burghardt hopes shortly to determine the chemical composition. A microscopical examination of the garnet grains showed them to be crystalline, exhibiting certain marked peculiarities, and after a careful examination of many of them he came to the conclusion that the form in which they crystallised was the rhombic dodecahedron. It is somewhat difficult to draw a conclusion as to the origin of these garnets in such a locality. From the microscopical examination of the rock it would appear that the cement and the garnets were *both* in a soft and pasty condition, the latter being probably formed whilst in the pasty matrix, and prevented from attaining a normal development. The quartz grains were probably formed previously to the garnets, as they appear to be waterworn pebbles, and were most likely carried along with the semi-paste-like mass which contained the constituents of garnet and calcite in its substance. When the paste hardened, the quartz grains and the garnets were enclosed in the manner exhibited on the specimen of rock from Ramsbottom. All the constituents of garnet were at hand, namely, aluminous shale, which would furnish the alumina and silica, and iron pyrites, which would furnish the iron, whilst water impregnated with calcium carbonate, acting upon the shale and iron pyrites, would bring about the necessary chemical changes, calcium sulphate being formed and carried away, and the garnet solution could then crystallise out. Another explanation of the occurrence of garnet in the conglomerate may be as follows:—Garnet is a very common accessory of crystalline rocks, occurring mostly in slates of various kinds, such as talc slate, mica slate, chloritic slate, and aluminous slate; it also occurs in gneiss, granite, porphyry, serpentine, and granular limestone. One or more of the above-mentioned rocks containing crystallised garnets already formed were disintegrated by the action of water, and the resulting *débris* (consisting of grains or pebbles of quartz and garnets) was carried away and deposited in a semi-fluid mass of silica and calcite, and thus cemented together

Mr. F. P. Venable, of the University of Virginia, has analysed an alloy known as "Tungsten-Manganese Bronze." A fragment cut from a small block of so-called tungsten-manganese bronze, of light gold-yellow colour, pretty close grain, and with a fine polish upon one side of the specimen (sp. gr. = 8·64), was carefully tested qualitatively, and the proportion of the constituents found were thus determined. No manganese whatever was present, and but an insignificant amount of tungsten. The alloy consisted of—Cu, 86·51; Sn, 9·04; Zn, 3·47; Fe, 0·26; W, 0·23; total, 99·51. It is therefore but an ordinary gun-metal, with part of the tin replaced by zinc. Of course manganese may have been added in its production, as well as a larger proportion of tungsten; but if so, they have failed to be taken up, or have been burnt out before the alloy was cast; and manganese so removed may have served in a measure to improve the compactness and homogeneity of the mass by carrying off with it oxygen from the remaining metals, as in the use of phosphorus in making "phosphor-bronze." But the name under which the alloy is sold is calculated to mislead purchasers.

Barff's process for the prevention of corrosion on iron surfaces is being applied on a very large scale. The process, shortly, consists of passing superheated steam over the iron goods to be treated whilst at a red-heat, and can be applied to all kinds of iron-work, rendering it absolutely rustless at a less cost than galvanising, so substituting an absolute protection for one which confessedly is but partial in its action and easily removed.

From the Annual Report by the Keeper of Mining Records we learn that the production of coal in the United Kingdom during 1878 was estimated at 132,607,866 tons, valued at £46,412,753. The quantity of iron ore is given as 15,726,370 tons, valued at £5,609,507. There were produced 29,867 tons of iron pyrites, worth £19,099. Of pig-iron there were 6,381,051 tons produced from ores obtained in the United Kingdom, valued at £16,154,992. The total decrease in the production of coal in the year 1878, as compared with that of 1877, was 1,955,876 tons. The production of pig-iron in Germany during 1878 was 2,124,444 metr. tons; zinc, 94,954; lead, 84,372; copper, 9541; tin, 831; antimony, 1245; coal, 39,429,308; lignite, 10,971,117; asphalte, 47,329. The total amount of pig-iron produced in France in 1878 was, according to "Engineering," 1,508,246 tons, most of which came from the Meurthe-et-Moselle. Pig produced with the aid of coke is greatly in demand, and is driving out charcoal pig and mixed sorts.

An attempt is contemplated to work coal-mines in the neighbourhood of Ching-men-Chow, not far from Tchang. Boring operations were commenced late last autumn. The coal-producing country appears to cover an extent of 758 square English miles, 15 long by 5 broad. There are two layers of coal, one above the other. It is supposed that 1,200,000 tons of coal can be raised from Wotzukow, and 800,000 from San-li-kang, at the rate of 40,000 tons a year. The supply thus would last at least forty years. It is highly probable that further explorations will bring to light fresh beds, as these discoveries are the result of merely the first investigations. Specimens of all the native and foreign coal procurable in China have been analysed together, and the new coal has shown itself superior to all for smelting purposes.

Requiring large quantities of platinum for his electro-chemical telephone, Mr. Edison issued, some few weeks ago, a circular letter of enquiry with regard to the possible occurrence of platinum in various parts of the United States. From the "Scientific American" we learn that Mr. Edison received some three thousand replies to his letter. Platinum, instead of being an extremely rare metal, seems to be widely distributed, and to occur in considerable abundance. It is found where gold occurs, and Mr. Edison thinks he can get 3000 lbs. a year from Chinese miners in one locality. One gravel-heap is mentioned from which a million ounces of platinum are expected!

PHYSICS.

Since the Lontin electric light was first used at the Gaiety Theatre several important improvements have been effected. The improved machine possesses three advantages, viz.—the low speed at which it works, thus reducing wear and tear, risk of accidents, and overheating; the ready division of the light; and the production of alternate currents. The number of different circuits which one machine can generate, and the number of separate lights obtainable from each circuit, are, it is said, only limited by the size of the machinery. The machines now in operation at the Aldersgate Street Station of the Metropolitan

Railway have been constructed by Messrs. Harding and Co., of Paris. The generator works at a speed of 400 revolutions a minute, and the inductor at half that number. The motive power is supplied by a Fowler 25 horse-power high-pressure compound engine, capable of working up to 60 horse-power, which will probably also be used for producing electric lights in the Metropolitan Meat-market and at other stations on the Metropolitan Railway. The cost of coal and carbons is reckoned at less than 3d. per hour for a lamp equal in lighting-power to 600 candles, with an expenditure of from 1 to 1¼ horse-power. The lamp employed is the Serrin-Lontin, and by the most recent improvement the carbons will only require renewing once in fifteen hours. A great advantage is that the lamps can be lighted or extinguished independently of each other. The experiments at the Aldersgate Street Station are being carried out by the Electric Generator and Light Company. The first evening this light was exhibited, Mr. Harding, of Paris, explained the progress and capabilities of the Lontin system. "The most interesting news on this subject is,"—remarks the "Telegraphic Journal,"—"the statement made by Mr. Harding, at the exhibition of the Lontin light, to the effect that Mr. Crookes is engaged on some experiments with the electric light *in vacuo*, which promise to work an entire revolution in the prospects of the light. Carbons would be dispensed with, and the lamp would consist of a luminous globe, giving the light of (say) three candles. Thirty of these lamps would, it was thought, be maintained by an expenditure of 1¼ horse-power, at a cost of less than a penny per hour. We have always believed that there was something to be made by some one, in the way of electric lighting, out of Mr. Crookes's researches *in vacuo*, and we are gratified to hear that that eminent physicist is so near success himself. Mr. Edison and he are trenching upon the same ground with vacuo; but whereas the former uses metal electropyres, the latter uses none. Both are on the proper track, it seems to us, namely, the production of a perfectly steady light without any wasting of carbons or other perishable parts."

The Siemens electric light is now employed in the Reading Room of the British Museum. The main difference between the method adopted by Messrs. Siemens and that experimented upon some time ago by the Société Générale d'Electricité consists in the use of four very powerful lamps hung high over the heads of the readers, instead of a number of less powerful lights at a lower elevation. These four lights are produced by continuous currents passing through wires carried over the roof of the Reading Room and through the top of the glass lantern in the centre of the dome. The electricity is supplied by five dynamo-electric machines placed in a shed at the back of the Museum buildings at about 200 yards distance, and worked from two 8-horse-power semi-stationary engines, supplied by Messrs. Wallis and

Steevens, of Basingstoke. The regulators are the invention of Messrs. Siemens and Halske, of Berlin. They each contain 19 inches of double carbon, which are consumed at the rate of 3 inches an hour. The lights consequently will burn for a little more than six hours without the regulators being interfered with. Seven other lights, of which two are placed in the Court Yard, one under the portico, one in the Hall, one in the passage leading to the Reading Room, and the remaining two in the engine house, are worked by two alternate current machines, and the regulators are actuated by two coils acting on a differential principle, one of them forming part of the main circuit and tending to separate the carbons, the other tending to bring them into contact. The position of the carbons depends therefore not upon the strength of the current, but upon the relative amount of electricity passing through each coil. The carbons burn for about five hours, and may be renewed in half a minute. The wires supplying the current for these regulators are laid partly in the basement of the building, and partly in pipes under the ground. The light given out by each of these lamps is equal to 600 candles, and their steadiness says much for the excellence of the principle upon which they are constructed. The powers of the light were severely tested by several of the gentlemen present. Mr. George Bullen, Keeper of the Printed Books, put it to several practical working tests in different parts of the room, and found that at the desks which are farthest from the centre there was a decided lack of light for those who, like Mr. Bullen, have somewhat impaired their sight by incessant literary labour, while at the catalogue desks and in the centre of the room, the light was much more than sufficient to read even the smallest print. The diameter of the Reading Room it will be remembered is exactly 140 feet, the half of which is 70 feet. As at present placed the three outer lamps hang at a distance of about 35 feet from the centre, and of course at an equal distance from the wall. A moment's consideration will show that according to this arrangement the central portion of the room gets an overplus of light, while the part near the wall is underlighted. Mr. Bullen consequently suggested that the three outer lamps should be hung at a distance from the centre of two-thirds of the radius of the circle, by which means each third of the line between the centre and the circumference would be equally illuminated. By moving the outer lamps nearer the wall the outer row of the catalogues will be taken out of the deep shadow in which they were thrown by the arrangement adopted on Monday. Dr. Carter Blake submitted the purity of the light to some very searching colour-tests, and found that the most delicate tints were as easily distinguishable as in bright daylight.

In his excellent lecture on "Electricity as a Motive Power," delivered to the working men at Sheffield during the Meeting of the British Association, Prof. W. E. Ayrton demonstrated that a dynamo-electric machine, with a separate exciter, driven very fast with a steam-engine, or with a stream of water, at high or low pressure, and sending, by even quite a fine wire, a small current to a distant electro-motor, also running very fast and magnetised by a separate exciter, is an economic arrangement for the transmission of power. As an illustration of what had been done by electricity as a motive power, Prof. Ayrton referred to the experiments of MM. Chrétien and Felix, who last year at Sermaize (Marne) ploughed fields by electricity, the electric current being produced by two of Gramme's dynamo-electric machines. These machines were usually worked with a steam-engine at some convenient place 300 or 400 yards away, in an adjoining road. The electro-motors were also two Gramme machines, one on each side of the field, with their coils revolving backwards. Through one of these the electric current was sent alternately, so that motion was given to one or other of two large windlasses, one on each of the waggons containing the electro-motors. In this way the plough, which could be used going in either direction, was first pulled across the field, making a furrow, and then back again, making another parallel furrow. M. Chrétien's electric crane has also been successfully employed for several months at Sermaize, in the harbour there, and it is considered that a saving of about 30 per cent has been effected of the expense formerly incurred for unloading the sugar-barrels out of the boats. Calculation showed that if electric currents—generated by very large steam-engines at certain points, and by turbines driven by the falling water on the hill-sides around Sheffield—were substituted for the use of coal for motive power, smelting, heating and lighting buildings, that a saving of something like £400,000 a year might be anticipated for that town. During the lecture electric lights, fed from a distance, were used. The current from a dynamo-machine at the works of Messrs. Walker and Hall, a considerable distance from the lecture-room, also set in motion an electro-motor on the platform. This in turn caused another dynamo-machine to rotate rapidly and produce a current with which the lecturer gilded a piece of plate. It was also shown that the Sheffield Water Company had a considerable surplus supply of water which could be used for producing motive power; and as an illustration of such a use of the water-power, a 2-inch board was sawn on the platform by a circular saw driven by an electric current generated by a water-engine in the yard of the Water Works, and conveyed to the hall by wires crossing the streets. In referring to the fact that electricity can produce not only motive power, but also light and heat, Prof. Ayrton said that Dr. Siemens had been able to effect a saving of about 30s. an hour, at the Royal Albert Hall, by replacing the old gas jets by electric lamps. The science of hanging a brilliant light high up had been luckily allowed to ride over the precedent of putting a number of feeble glimmers all over the building.

A new thermo-electric battery has been invented by M. Clamond for the production of the electric light. With a consumption of 9½ kilos. coke, a current is produced capable of maintaining four lamps, each equal to twenty-five Carcel burners.

In the American "Quarterly Microscopical Journal" Mr. F. H. Wenham gives some useful information relating to practical methods of obtaining parabolic forms. The mode of forming the template is simple and ingenious:—A cone of hard wood or metal is turned, removed from its centre, and fastened by one of its sides on a suitable chuck; a section is made in the lathe parallel to the attached side; a piece of accurately flattened brass, somewhat larger than the section, is fixed to the portion of the cone by screws, and above that a piece of similar material to that from which the cone was turned; it is then returned to its centre, and the cone turned down to its original form: the metal plate has its edges finished by holding to it a "dead smooth file." The cone is unscrewed, and the brass plate comes out a true parabola. The block of glass is turned with an old saw file and plenty of turpentine until it approximately fits the template; the paraboloid is then turned with a keen edge until the template, smeared with reddle and oil, marks it evenly all over; the marks are ground out with a small block of brass and emery of graduated fineness, until all scratches disappear. The glass is polished with a buff stick and crocus and water, and finally a piece of hard bees' wax is held against it, with finer crocus, to obtain the last degree of polish. If the paraboloid be a non-immersion one, with a cupped top, it may be turned flat on the end until the required thickness is arrived at, and the hemispherical cavity roughly turned out to a half-circle template till the centre is brought to the focus: the cavity is then finished in the same way as a concave lens. Finally, when rotatory in the lathe, the paraboloid is perforated through the axis with a steel drill and turpentine.

A new "Catalogue of Electric Apparatus" has been issued by Mr. E. Paterson, Bedford Court, Covent Garden. This Catalogue has the double merit of being copious and well illustrated with nearly 160 woodcuts. The first part contains a priced list of apparatus used for instruction and demonstration, while the second deals entirely with practical matter or applied electricity. In the second part a clear description is given of the construction of electrical apparatus intended for house signalling, bells, telegraphing short distances, &c. The telephone and electric lamp are also described. The directions given for fixing electric house-bells are sufficiently clear and devoid of technicalities to be of service to any ordinarily intelligent builder or bellhanger.

PHILOS SOC

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I. A VISIT TO THE ANCIENT OBSERVATORY AT DELHI, LOCALLY KNOWN AS THE "JUNTER MUNTER."

By H. A. Tracey, Major R.A.

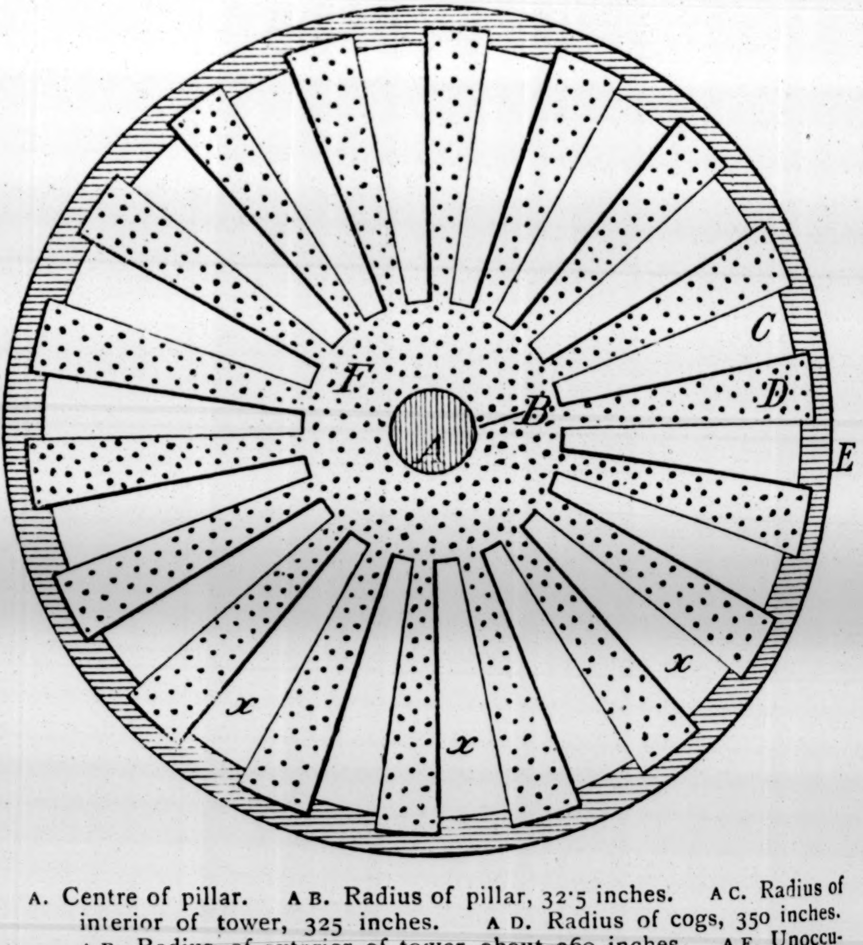
DURING the visit of H.R.H. the Prince of Wales to Delhi, in the winter of 1875-76, my battery, among many others, was temporarily stationed there, and after H.R.H.'s departure I employed our few leisure days in visiting the interesting remains of ancient grandeur that dot the country for 10 or 12 miles to the south of the modern city.

One of the most conspicuous is the great Sun-dial, erected by Rajah Jey Sing, about A.D. 1720. Its gnomon is a very remarkable object, rising stiff and angular some 60 feet above the plain. Those who mount the narrow stairs that lead to its summit find it crowned by a "Lingam," sure sign of a worship of "Baal" as descended to these days. There were the yellow flowers and grains of rice on and about it, showing that it is a "high place," still used by the neighbouring peasantry.

This Sun-dial, though the most prominent, is not the most important part of the remains of the Observatory. Two low towers, about 24 feet high and 60 feet in diameter, attract one's attention when on the gnomon, and lie due south of it. As seen from that more elevated spot their cylindrical exterior is at once noticed, and the observer has also the opportunity of remarking that the tower is open to the heavens; that a central pillar rises in each to the same height as the walls, which have deep vertical recesses on their inner surface, so that, while the exterior plan of each tower would be represented by a circle, a cogged wheel would show the shape of the floor inside.

From a certain spot on the flight of steps running up the gnomon, the central pillar of each tower can be observed as being truly level with its surrounding wall. From this spot another peculiarity can be seen:—The projecting teeth of the imagined cog-wheel are apparently the same as the intervals between them. Both the towers seem in every respect alike, except that the nearest of the two towers has its northern cog in a line with us and its central pillar, while the furthest tower has one of the intervals between

FIG. I.—GROUND PLAN OF TOWERS. $\frac{1}{200}$ Scale (Natural).
Shaded portions brickwork; dotted parts rank grass and filth.



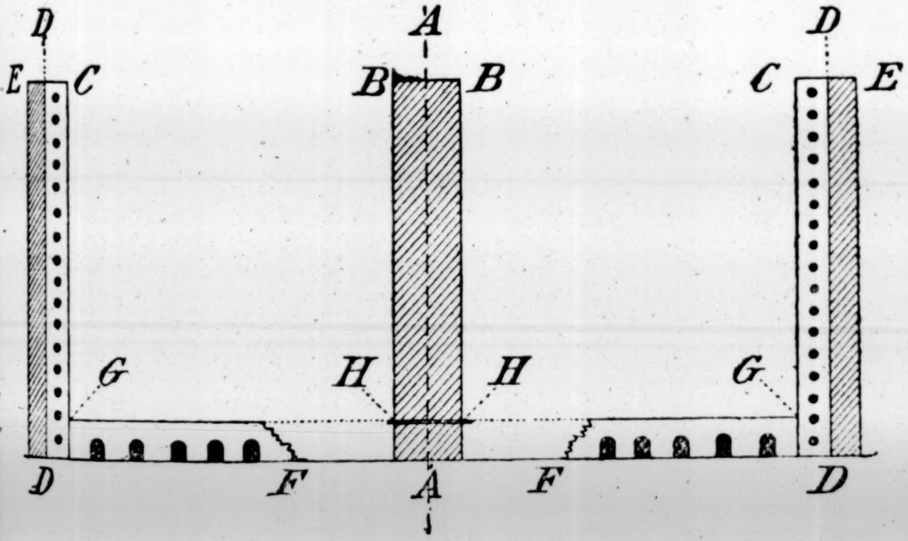
A. Centre of pillar. A B. Radius of pillar, 32·5 inches. A C. Radius of interior of tower, 325 inches. A D. Radius of cogs, 350 inches. A E. Radius of exterior of tower, about 360 inches. A F. Unoccupied interval, about 130 inches. *x x*, &c. Raised sectors with "ivory" cement covering.

the cogs in the same line, as if indeed the southern tower had been turned in azimuth through the space of one cog. With this exception the towers seemed similar.

The towers are well built of brick, and plastered. A small doorway in each led to the inner floor, 5 or 6 feet below the present level of the adjacent ground.

In the interior the first rough plaster is covered with a fine hard one everywhere; and that again on the portions marked with lines, &c., for observation, bore a still finer plaster, that, wherever I remarked it, had a surface, touch, and colour that can fairly be compared to ivory.

FIG. 2.—VERTICAL SECTION THROUGH CENTRE. $\frac{1}{200}$ Scale (Natural).



A A. Centre of pillar. A B. Radius of pillar, 32·5 inches. A C. Radius of interior of tower, 325 inches. A D. Radius of cogs, 350 inches. A E. Radius of exterior of tower, about 360 inches. A F. About 130 inches. C G. 292·5 inches. C B G H is a square, and the angle C G B = 45°. The dots along C G are the pigeon-holes for the feet.

A zealous "Sub" helped me in making the measures from which the accompanying plan and section of the towers are drawn.

To commence with the plan, Fig. 1.

The floor may roughly be described as a cart-wheel in shape, the eighteen spokes of which are raised from the ground (see Fig. 2) on five—I think, but not recorded in my notes—low arches. The intervals between the spokes are of equal breadth with the raised parts, and are at present covered with the exuviæ of the human and animal population of the neighbourhood. These portions of the floor each extend about 2 feet radially into the thickness of the wall, and, carried up vertically, give the cog-wheel-like appearance to the inner plan of the towers, as noticed when looking down on them from the gnomon. On each side of these recesses are pigeon-holes, of a convenient size for the feet, so that, by straddling across from side to side, an observer can easily mount, resting his back against the wall, up to the top, and bring his eye with ease to the edge on either side, on which are marked the angles of depression from the edge of the flat top of the centre pillar. Along these vertical edges the degrees are numbered in Hindoo (Sanscrit), not Arabic figures, the *Z*ero being at the top, and the 45th degree at the angle where the vertical and horizontal portions of fine work meet (see the angle marked G in Fig. 2). The *Z*ero point (C, Fig. 2) was in every case removed. (Every fifth degree was marked in figures, the others by a line only.) I walked round the summit of each tower to assure myself of this, as I was anxious to find one *in situ.* It had apparently been marked by the edge of a stone about a foot square, and so would be a convenient size for grinding curry-stuff on. Such stones are in daily use by all the inhabitants of the country, and being ready cut and levelled would naturally be soon appropriated. And the flight of pigeon-holes led directly up to them.

Each of the observing recesses had three windows, lancet-shaped, together forming three rows of windows round each tower: they were of no apparent value, and were draughty and dangerous for an observer. Some were bricked up, and I regret I did not record the position of these, as it might have given an idea of the direction from which observations were most frequently taken.

The eighteen spokes being of the same width as the intervals between them, it follows that the circular floor was divided into thirty-six equal divisions of 10 degrees each. And now we learn the value of the *two* towers—as the raised "spokes," or "sectors" as we shall prefer to call them, in one occupied the place of the unmarked floor in the other. Each of these raised sectors, and the vertical wall adjoining them, had been once covered with the fine "ivory" cement I have spoken of. But little of it remains on the broad surfaces, as it seemed to have suffered from the weather and the frosts not uncommon here in January and February; though in the salient angles formed by the recesses I have mentioned it was more perfect than elsewhere, and the lines and figures on it were generally legible. They had apparently been drawn by some blunt fine-pointed instrument before the cement was quite dry. Each sector was divided radially into six divisions by five deep lines, and each division into five subdivisions by finer lines. So each large division represented 10° divided by 6, or—

$$\left(\frac{10^\circ \times 60'}{6}\right),$$

100 minutes of azimuth angle; and consequently each finely-marked subdivision equalled 20′ of angle.

I am not able to say positively that these finer subdivisions were continued on the vertical walls. I saw some parts where the fine cement appeared intact, but not within reach, where I *thought* the finer lines apppeared, but I was not certain. They did *not* exist on the index edges, where the written numbers of the degrees were marked. The inner ends of the sectors were much damaged, the open space between them and the centre pillar being anything from 6 to 8 feet.

The centre pillar has a ring of well-cut stones, eighteen in number, on a level with and corresponding to the eighteen sectors. They are of the fine red freestone of the district, and project from the pillar about 2 inches (not exactly recorded in my notes). Their upper surface is level and finely dressed, and divided equally by radial lines into six parts. The space between each stone—equal in width to the stone itself—is occupied by a red stripe running vertically the whole length of the pillar. The pillar itself is divided above the level of the projecting stones, by clearly-marked red rings, into five horizontal blocks, each block being subdivided by finer horizontal lines into nine smaller blocks.

Judging by eye, and with the assistance of my Lieutenant on the opposite side of the tower, it was clear that the middle of each of the bolder red rings was intended to be (and indeed was) on the same level as the 36°, 27°, &c., marked on the index edges of the observing recesses. And the marks were as closely accurate as we were capable of discerning with the unaided eye. The level stone on the summit of each central pillar was in its place, with the edge angle very fine dressed.

In the northern tower, which is the one nearest the Sun-dial, the prolongation of the gnomon's western face is marked by a window, unlike the others in the tower. It is of lancet-shape, but extends from second to third row of windows counting from the ground; its *apex* marks the prolongation of the north and south line, while the same line on the opposite side of the tower falls exactly on the edge of another window, signalised by being splayed out on that particular side into an exceptional shape, and leaving the edge required for observation dressed with the fine "ivory" cement. The N. and S. line only just clears the centre pillar. The same line is carried through the southern tower, falling on the other side of its centre pillar (I think so at least, though I did not record it in my notes made on the spot), and its position is again marked by fine edges of the "ivory" cement, though the windows are not of such exceptional shape as in the northern tower.

All the above lineal measures were made with a folding rule of box-wood, by Adie, of Edinburgh, and specially tested at the Observatory of that city for accuracy. It is 25 inches in length. One side of the rule was marked to tenths, and the other to half-tenths of an inch.

The measures on the walls and sectors we considered trustworthy; those connecting the walls with the centre pillar were carried out with difficulty. A plumb-line was dropped from some well-marked position at the edge of a sector, and then, by means of two boards alternately moved, the measure was carried step by step across the filth that covered the ground. A tight string gave a straight line, but no special means were taken for levelling. Direct measures from wall to pillar were also made in the same manner.

The general result of our measures were—

	British inches.
Radius of the interior of the tower	325·0
,, ,, centre pillar	32·5
Height of finely-cemented portion of tower, inside above the sectors: mean of several measures	293·8

In this last measure, which theory demands should be 292·5 inches, it must be remembered the original index edge had been removed for the vertical, and we were guided by eye alone, taking the centre pillar's top and the opposite side of the tower as our guide.

I noticed that the index markings for vertical angle were not too truly marked; several had double lines. Those in azimuth were not too accurate. The box-wood rule allowed of its being bent against the inner circumference of the wall, and the width of the divisions in azimuth were carefully recorded.

	Inches.
8 are each recorded as	5·75
1 is recorded as	5·70
1 ,, ,, ...	5·72
Mean	5·74

Each of these divisions represent 100 minutes of horizontal angle.

Having completed, as well as time permitted, our measures of the towers, we devoted our spare time on the second day to a closer inspection of the great Sun-dial.

It is built on the edge of a natural, or perhaps artificial, depression in the ground, so that, though it only stands some 60 feet above the general level of the country, its perpendicular face really has a front of about 90 feet, the excavation at its foot giving it that additional height. From each side of its foot, and (in plan) at rather less than a right angle, sweep up the great arcs on which the shadow falls.

The Western one is quite ruined : a large badger appeared its only tenant, and watched us. The Eastern one had enough remaining to enable us to follow the shadow over the few existing legible markings, by mounting a very narrow and hazardous flight of steps which followed the sweep of the arc. As I mounted the ruined steps, spare remnants of the "ivory" cement called my attention, and it was clear that the crest of the parapet between me and the gnomon was the dial on which the time was marked.

Waiting till the sun was low I was able to watch the shadow moving over some of the more perfect portions of the scale. The workmanship was kindred to that of the towers—brickwork, rough plaster, finer plaster, and for the inscribed portions the "ivory" cement. I was not able to measure the angular divisions of the circle on this arc, but I could see the markings were finer than could be read, or, in other words, the penumbra on the edge of the shadow was wider than the space between each of the finer marks, so that its fall on each could not be noted accurately by my unpractised eye. These smallest divisions were arranged in groups of five. A blank concentric space of the same angular value marked each block of five, and an inner curve again gave larger divisions, but there was no portion of plaster left large enough to count how the enumeration was commenced.

An eye accustomed to watch the record of this great dial could no doubt read it to a fraction of a minute ; but with such a broad penumbra no two observers could, I think, give similar independent readings.

On our two visits to the top of the gnomon we took frequent measures of its angle ; they all lay between—

28° 15′ and 28° 45′ (mean 28° 30′),

or close on the real latitude of the spot.

The substructures and architectural arrangements for the Eastern arc of the Dial were made subservient to many purposes, chief of which we noticed a narrow gallery or chasm running due N. and S. I hardly know how to describe it. In ground plan it would be a narrow parallelogram, about 6 feet wide; in side elevation, wedge-shaped—its central line in the direction of the mean angular midday elevation of the sun; the vertical height of this wedge being that of the arc, or about 60 feet. The apex of this wedge is a well-cut horizontal slit, about 2 inches wide, in a finely-dressed stone, and not to be noticed at first in the ruined condition of the outside; but inside the curious vault at midday its meaning is evident, as the line of sunlight falls across an arc, ready marked, recording the sun's vertical height at noon during the year.

The visit was an interesting one, but I left the "Junter Munter" with the idea that it was only the scientific toy of a rich man, with yearnings maybe ahead of his time; and when "Jey Sing" was gathered to his fathers, I imagine the "Junter Munter" soon fell into a respectable disuse.

II. THE ACTION OF LIGHT ON PLANTS.

IN his Presidential Address at the Sheffield Meeting of the British Association, Dr. Allman remarked that in by far the greater number of plants the protoplasm of most of the cells which are exposed to the sunlight undergoes a curious and important differentiation, part of it becoming separated from the remainder in the form usually of green granules, known as chlorophyll granules. To the presence of chlorophyll is due one of the most striking aspects of external nature—the green colour of the vegetation which clothes the surface of the earth; and with its formation is introduced a function of fundamental importance in the economy of plants, for it is on the cells which contain this substance that devolves the faculty of decomposing carbonic acid. On this depends the assimilation of plants, a process which becomes manifest externally by the exhalation of oxygen. Now, it is under the influence of light on the chlorophyll-containing cells that this evolution of oxygen is brought about. The recent observations of Draper and Pfeffer have shown that in this action the solar spectrum is not equally effective in all its parts; that the yellow and least refrangible rays are those which act with most intensity; that the violet and other refrangible rays of the visible spectrum take but a very subordinate part in assimilation; and that the invisible rays which lie beyond the violet are wholly inoperative.

In thus acknowledging the labours of Draper and Pfeffer, Dr. Allman forgot the previous researches of Mr. Robert Hunt, F.R.S., who investigated the subject forty years ago. Dr. Allman, however, in a letter to Mr. Hunt, observes, "I have been refreshing my memory of your researches by reading your published account of them, and their completeness and conclusiveness render my regret the greater that I had not given them the recognition they so well merit." The results of Mr. Hunt's "Researches on the Influence of the Solar Rays on the Growth of Plants" were described to the British Association in 1842 and 1846, and are given in his "Researches on Light."* In his history of the progress of the inquiry, he refers to Dr. Priestley's experiments in 1779. These researches, which showed that carbonic acid was absorbed by the plant, that under the influence of light it was decomposed, and that its oxygen was again liberated, were confirmed by the experiments of several naturalists and chemists, including Senebier, Ingenhousz, DeCandolle, Saussure, and Ritter. The general result of the investigations on the chemistry of vegetation up to this point was, Dr. Hunt observes, that light was essential to healthful vegetation, but that the decomposition of the carbonic acid by the plant took place more decidedly under the influence of the most refrangible range of the spectrum than of those which possessed superior illuminating power. In 1801 Labillardière communicated to the Philomathic Society his discovery that light was necessary to the development of pores in plants; and about the same time Victor Michellotti announced that light has a decided action on those germs which are exposed to it,—that this action is prejudicial to them, and it manifests its action by retarding their expansion if the light be weak or a deflected light, or by total extinction of their life if it be very intense, as that which comes directly from the sun. M. Macaire Prinseps observed that sheltering leaves from the action of light prevents their change of colour in the autumn; that if the entire leaf was placed in the dark, it fell off green; if only a part, the rest of the parenchyma changed colour, and the covered portion retained its original colour.

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* Researches on Light in its Chemical Relations, embracing a consideration of all the Photographic Processes. By Robert Hunt, F.R.S. Second Edition. London: Longmans. 1854.

Mr. Hunt's own experiments extended over seven years; they were made at every season of the year, and the localities in which they were carried on were changed from the south-western extremity of the kingdom to the neighbourhood of the metropolis. The problem he wished to solve was the proportion and kind of influence exerted by light, heat, and actinism in the various stages of vegetable growth. The experiments were made under the action of those radiations which had permeated variously coloured media, such as tinted glass and coloured transparent fluids. We should like, did space permit, to refer to the many precautions taken in order to render the experiments exact and conclusive. We can, however, only give the results, referring our readers to Mr. Hunt's own account for further particulars of his observations. These results are as follow:—

1. Light prevents the germination of seed.
2. Actinism quickens germination.
3. Light acts to effect the decomposition of carbonic acid by the growing plant.
4. Actinism and light are essential to the formation of the colouring-matter of leaves.
5. Light and actinism, independent of the calorific rays, prevent the development of the reproductive organs of plants.
6. The heat radiations corresponding with the extreme red rays of the spectrum facilitate the flowering of plants and the perfecting of their reproductive principles.

In order to ascertain the exact conditions in which the luminous actinic and calorific principles exist, Mr. Hunt made frequent examinations of the condition of the solar radiations. He found that in the spring the actinic principle is most active, and as compared with light and heat it is considerably in excess. As the summer advances the quantity of light and heat increases relatively to the actinic principle in a very great degree. In the autumn light and actinism both diminish, and the calorific radiations are relatively to them by far the most extensive.

The term *light* is here used to express all those rays of the spectrum which are visible to a perfectly-formed human eye; by *actinic principle* is meant the principle to which the phenomenon of chemical change under solar influence belongs; and by *calorific radiations*, not merely those effects which are traceable by any thermometric instruments, but also those which we can detect by the protection from change produced by a class of rays existing near the point of maximum heat in the spectrum. In the spring, when seeds germinate and young vegetation awakes for the repose of winter, we find an excess of that principle which imparts the required stimulus; in the summer this exciting agent is counterbalanced by another possessing different powers, upon the exercise of which the structural formation of the plant depends; and in the autumnal season these are checked by a mysterious agency, which we can scarcely recognise as heat, although connected with thermic manifestations upon which appears to depend the development of the flower and the perfection of the seed."

The phenomena which the prolonged action of sunlight produces on vegetation in high latitudes are recorded by M. J. A. Broch, in a work recently published.*

The farther we go eastward from the Gulf Stream the more severe is the climate, even though the degree of latitude be the same. Thus Scandinavia and Finland possess an exceptionally mild climate, considering their high polar altitude. Indeed barley and oats will ripen in the most northern districts of Norway, Sweden, and Finland, and immense forests are met with; whilst in Iceland, Greenland, and the Polar confines of Russia and America, the earth is bare and sterile, and there are eternal snows. The cause of these advantageous climatic conditions is to be attributed to the enormous mass of warm water and hot air which the Gulf Stream brings down from the Equatorial region to the coast of Norway, which coast it approaches between 60° and 61° of latitude. This circumstance, together with the difference in the geological formation of the various northern countries of Europe, naturally lead to certain dissimilarities in the respective climates of these countries. Comparing Norway and Sweden, for instance, in the former the sun is moist, cloudy, and the quantity of rain considerable, the winters mild and the summer cold; while in Sweden the sun is brighter, the air drier, the quantity of rain less, the winters are cold and the summers hot. The isothermic line passing through the places whose mean temperature is zero,—skirting in Norway the chain of mountains and the sea coast from the North Cape, embracing also the central part of that country between the 60th and 63rd parallels—begins in Finland at the 66th degree of latitude, and rises rapidly to the north, forming a curve which encloses the elevated lands of the interior between the Gulf of Bothnia and the Arctic Sea, so that not only the countries situated south of that parallel, but also those which slope towards the Arctic Ocean and are submitted to the salutary influence of the Gulf Stream, have a mean temperature above zero. Of all the countries situated in the same latitude as Finland, the Scandinavian peninsula alone enjoys a milder climate. European Russia is much colder, and the climate of Asiatic Russia still severer. The neighbourhood of the sea and the abundance of lakes—in the number of which no country in Europe, or perhaps in the world, can compare with Finland—cause a tolerable quantity of rain to fall, and render the climate somewhat humid.

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* Le Royaume de Norvège et le Peuple Norvègien, par J. A. Broch, Ancien Ministre de Norvège.

With regard to the action of prolonged solar light on the vegetation common to all those countries, Dr. Schübeler, of the University of Christiana, has demonstrated that the seed of corn or other plants obtained from the northern regions ripens more quickly than that produced in the more southern countries. In the regions of the extreme north, where grain crops are uncertain in their yield, owing partly to the elevation of the land above the level of the sea, the seed corn of the north is always used in preference to any other. It is not less true that the various kinds of grain and vegetables cultivated in the northern regions yield better and are much richer in carbo-hydrates than the varieties cultivated more to the south. The colour, moreover, is deeper—a phenomenon which applies also to all trees and plants. Foreign botanists visiting Norway, and the other countries of the extreme north, in summer, are astonished at the fresh dark green of the foliage and the bright colours of those flowers which grow both in northern and southern climes; and as this richness of colour increases regularly with the latitude, trees and plants have at first been considered as new varieties. The leaves of trees grown in the north are larger even when the seed has been brought from more southern countries. M. Schübeler has likewise proved that the aroma of all kinds of plants and fruits, both wild and cultivated, increases as the north is approached. Ordinary vegetables and herbs grown in high latitudes have a far more aromatic taste than those grown in more southern countries. The meadow cumin (*Carum Carvi*) is an example of this fact: grown at Christiana it contains 5·8 per cent of volatile oil, whilst that cultivated in Germany and Central Russia contains only from 4·0 to 4·8 per cent. But this large development of aromatic essence is not always considered an advantage; for instance, the tobacco plant grown in Norway or other northern countries contains, it is said, too much nicotine. In proportion, however, as the aroma increases with the latitude the saccharine substances diminish: the berries and fruits of the north are less sweet than those which are cultivated or grown wild in the more southern parts of those countries. Consequently whilst Norway as well as Sweden, and even Finland, produce the most delicious apples, the pears are not sufficiently sweet.

These facts, as well as the rapid growth of vegetation in the northern regions, are attributed to the prolonged action of solar light. Indeed at Christiana, at the summer solstice, the sun remains below the horizon only 5 h. 17 m.; at Froudheim, 3 h. 34 m. At Bodô, the chief town in Nordland, the sun does not descend below the horizon from the 2nd June till the 11th July; at Tromsô, from the 20th May to the 24th July; at Hamerfest, the chief town of Finmark, from the 15th May to the 29th July. On the other hand, the centre of the sun does not appear above the horizon at Bodô from the 14th to the 28th December; at Tromsô, from the 25th November till the 16th January; and at Hamerfest, from the 20th November to the 21st January.

It is not surprising that barley, potatoes, and many other plants and vegetables ripen in the most northern latitudes, seeing they are exposed to a considerable amount of heat during two or three months of the year. In those regions where the sun hardly descends below the horizon in summer, there is no night, only a short twilight; the growing plant therefore enjoys permanently, and without interruption, the heat and light which it requires.

III. TECHNICAL EDUCATION IN ENGLAND, FRANCE, AND GERMANY.

THE City of London Guilds and other corporate bodies seem at length to be convinced of the absolute necessity of adopting some measure for the advancement of technical education in England. As far back as the Paris International Exhibition of 1867 our English masters and workmen awoke to the fact that the leading position which we had formerly occupied as makers of the world's goods was being endangered by the talent and enterprise of foreign nations. The first note of alarm was sounded by Dr. Lyon Playfair, in a letter addressed to Lord Taunton, the Chairman of the Schools Inquiry Commission then sitting. The aim of this communication was to enquire whether England was really losing her high position in those industries which involve the application of scientific knowledge to production, and, if so, whether this retrogression was due to our comparative backwardness in the diffusion of a knowledge of applied science amongst the working classes. The British Commissioners appreciated the warning at its proper value, and, taking advantage of the presence in Paris of some of the most eminent British men of science of the day, they consulted them on the subject, the result being that, with scarcely a single dissentient voice, they affirmed that the lack of technical education on the part of British masters and workmen was slowly, but surely, undermining the position of Great Britain as mistress of the industrial arts.

Speaking generally these salutary warnings have been neglected, although in some few isolated instances they have been duly acted upon. These praiseworthy efforts have for the most part been the work of individuals, and as such have only wrought good in particular localities, anything like combined action being entirely wanting.

Amongst the latest utterances on this vitally important subject, the paper on "Apprenticeship Schools" read by Prof. Silvanus Thompson before the British Association at Sheffield, and just republished in pamphlet form,* and the Address of Prof. Ayrton at the opening of the City and Guilds of London Institute,† are the most striking. The gist of these able contributions to our knowledge of the subject is that our present system of apprenticeship is utterly rotten, and must speedily be replaced, under the penalty of seeing the whole of our trade with foreign nations gradually drift away from us. During the last half century apprenticeship, as it was understood by our forefathers, has ceased to exist except in name. The master of the present day, unlike his predecessors, seeks his own benefit instead of his apprentice's, and looks more to what he can make out of him than what he can teach him. A boy of fourteen enters a workshop willing and anxious to learn his trade; for the first year or so he finds himself in the position of a mere errand-boy, or at any rate the servant instead of the pupil of his superior. As soon as another apprentice can be found to do his drudgery he is set to some particular branch of work, and if the shop be a large one he will very probably be kept at it till the end of his term. He is placed under a workman from whom he learns but slowly, seeing that his teacher, being constantly employed on his own work, has but little time to teach him,—the evil reaching its highest point in places where piecework is the rule. It is no one's duty to teach him, and, as it formed no part of the contract between employer and employed, the journeyman very justly refuses to expend any very great portion of his time in instructing his master's apprentice in the secrets and mysteries of his handicraft. As for the master, the boy receives no help from him, even supposing that he is competent to teach him. He consequently picks up his knowledge of one small branch of his trade in an unintelligent and desultory manner, and leaves the workshop at the end of seven years capable of doing only one thing, and that by rule-of-thumb, just as his shopmates have done before him. How differently things were managed in what may truly be called the good old days of apprenticeship! In those times the master was also a workman, and laboured at his craft. He had learned every branch of it, and understood it so thoroughly as to be able to teach it to others. Capital and steam have together created gigantic factories, and the old domestic workshop—in which each worker formed part of a kind of family—gradually became the exception; the master craftsman became the mere employer, and the apprentice the boy worker.

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* Apprenticeship Schools in France. By SILVANUS P. THOMPSON, B.A., D.Sc., F.R.A.S., Professor of Experimental Physics, University College, Bristol. London: Hamilton, Adams, and Co.

† The Improvements Science can effect in our Trades and in the Condition of Our Workmen. By Prof. W. E. AYRTON.

The connexion between the depression of trade in skilled industries and the question of proper technical education, as well as the hopelessness of attempting to galvanise the old system of apprenticeship into life, is well pointed out by Mr.

George Howell in the "Contemporary Review" for October, 1877.

The question now is, what modern substitute for the old system can be adopted to the wants and wishes of the nineteenth century? Prof. Thompson's investigations happily enable us to lay before the reader the actual results of certain experiments recently made in France with a view to organising a new system of apprenticeship that shall be more in accordance with the social conditions of the present day. These results prove that the systematic instruction of apprentices is possible in several different ways; that apprenticeship schools afford a most satisfactory way of attaining this result; and, lastly, that the new system solves the problem involved in the decay of the old apprenticeship. The problem to be solved, stated briefly, is this:—How to give artizan children the technical training and scientific knowledge which their occupation demands, without detaining them so long at school as to give them a distaste for manual labour. The problem may be solved in four ways, all of which have been tested:—

First. We may apprentice children at an earlier age than at present, making it obligatory that all through their apprenticeship they shall every day have a certain number of hours of schooling in a school attached to the workshop.

Secondly. The children may be kept at school for a longer period, on condition that they shall pass a certain amount of time in a workshop attached to the school.

Thirdly. We may organise a school and workshop side by side, an equal number of hours being devoted to manual labour and study.

Fourthly. We may send the children for half the day to the existing schools, and the other half to work half-time in the workshop or factory.

The first of these plans strongly commends itself to our attention, for the knowledge imparted in the school could be correlated to the work done in the factory, to the manifest benefit of both the employer and the employed. This system has been tried in France for the last thirty years, and the establishment of MM. Chaix and Co., the French Railway Guide printers, may be cited as a type of the whole. MM. Chaix's typographical school—for such it really is—has been in existence for seventeen years, and has supplied nearly a hundred able workmen to the firm itself, and the few who have left have found exceptionally good situations. The apprentice is bound for four years, the employers guaranteeing him a place when he is out of his time. They are divided into two classes, compositors and printers. Close to the composing- and press-rooms there is a schoolroom, where the apprentices of both classes spend a couple of hours daily, either in improving their knowledge of the three R's or in going through a technical course of typography, including grammar, writing and composition, reading and correcting proofs, the study of the different kinds of type, and so on. They are also taught to read and set up in type Greek and Latin, without any attempt to instruct them grammatically in these languages; and they are taught the rudiments of English and German. Lastly, there is a course on such subjects as the history of typography, or mechanics, physics, and chemistry, as far as they apply to printing machinery and processes. During the three years the apprentice compositors receive from 5*d.* to 2*s.* per day, and the printer apprentices from 7½*d.* to 3*s.* 8*d.* At the end of the term most of the apprentices prefer to remain in the employment of the firm, and can then earn from 3*s.* to 6*s.*, according to their ability. Great pains are taken to systematise the teaching. The compositor apprentices are set to work under the direction of a foreman whose chief business is to instruct them, and not to work for his own or his employer's benefit: he is, in fact, a professor of printing, just as Professor Thompson is a professor of Physics.

MM. Chaix's establishment, it must be understood, is only one of over two hundred similar schools in different parts of France, in which a similar system of instruction is given in the manufacture of optical instruments, shirts, jewellery, paper, Italian paste, ribbons, calicoes, plate glass, silks, bookbinding, and a dozen other branches of trade.

A great impetus has been given to this kind of apprenticeship schools by the passage of a law, in 1874, forbidding the industrial employment of children under 12, except they receive two hours schooling per day; nor may children over 12 and under 15 be employed for more than six hours per day, unless they have finished their elementary education, their employers being made personally responsible for carrying out these regulations.

In the school of M. Soufflot, a jeweller, the character of the instruction is purely technical. The success which has attended the "school on the workshop system," as Professor Thompson aptly calls it, must not only be extremely gratifying to all who have the cause of technical education at heart, but it must also prove to the attentive observer that, being the most natural, it will eventually become the best system of all.

The second type of school includes those in which systematic instruction in one or more handicrafts is given to boys who are still going on with their elementary instruction. There appears to be one school of this sort in Paris, which is carried on most successfully as far as it goes, only about 12 per cent, however, of the pupils receive manual instruction. They work alternately at carpentering, wood-turning, forging, filing, chipping, and metal-turning for two years; after which they specialise their work. They also receive instruction in modelling and technical drawing, and in the summer they visit the neighbouring factories. On the completion of the preliminary two years they are draughted off into one of the three special workshops in which modelling and carving, carpentry and wood-work, and iron- and metal-work are carried on under the superintendence of master-workmen who have made the teaching of their various crafts a special study. One of the disadvantages of this type of school is, that the instruction given is professedly only preparatory to, and not a substitute for, an ordinary apprenticeship. In its favour it must be conceded that it shortens the long and useless years of apprenticeship, and thus helps the young worker to become a bread-winner.

The third system is where the school and the workshop are placed side by side, so that the hours given to study should be co-ordinated with an equal number of hours of manual instruction. This type of school Prof. Thompson thinks is the *apprenticeship school* of the future. France affords two good examples of this class; one the Paris Municipal School of Apprentices, where several distinct trades are taught; and the Besançon Municipal School of Horology, where clock and watch making alone are taught. Taking the Paris school first, we find that the apprentices are only admitted between the ages of 13 and 16. They must also have a certificate showing that they have completed their elementary education, or else undergo an examination. In comparison with schools of the second type a larger amount of time is devoted to the workshops, which are here much more extensive and complete. The course is a three years' initiation into the handicraft taught, and the majority of the pupils leave the school able workmen. The trades in which direct instruction is given are those of the carpenter, wood-turner, pattern-maker, smith, fitter, and metal-burner.

That the school turns out excellent workers may be judged from the fact that the average age of the pupils who left the school in 1877 was 17½ years, and their average earnings in the places they had obtained was 3*s.* 1½*d.* per day, one boy of 17 getting as much as 5*s.* 4½*d.* per day as a smith. The instruction is entirely gratuitous, and the whole of the necessary tools, machines, books, &c., are supplied by the Municipality. The system pursued in this school appears to be of the very highest order, and should serve as a model for all future schools of the kind. The Besançon School of Horology is managed on similar principles, and is a striking success. The school is managed and supported entirely by the Besançon Municipality. In addition to instruction in every branch of horology, the apprentices receive lessons in their own language, arithmetic, algebra, geometry, physics, chemistry, mechanics, and drawing, in so far as they relate to horology.

The only system remaining for consideration is that of half-time schools; the system has, however, been almost discarded in this country, and has only been partially tried in France. One radical defect in it is, that there is no correlation between the work done in the factory and the information imparted by the schoolmaster; the whole of the pupils, whether they are intended to be mechanics, dyers, or printers, all receive the same kind and quantity of instruction.

So much for the good work that is being done in France, which of all European nations is certainly in the van with regard to lower technical education.

In September last Prof. Thompson visited Germany in compliance with the advice of Mr. Mundella, who, in criticising his paper at the British Association, placed the German technical schools above the French. Prof. Thompson paid visits to the Polytechnicum and Weaving Schools at Chemnitz, these being the special establishments pointed out by Mr. Mundella, and found, as he expected, that although the higher technical training schools in Germany were superior to those elsewhere, they could show nothing in any way equal to the Paris Municipal Apprentice School described above.

Prof. Thompson's investigations have been so thorough, and lead to such practical conclusions, that they should receive the serious consideration of those whose business it will be to organise either national or local systems of technical education.

The movement of the City Companies has resulted in the setting aside annually of £15,000 for the promotion of technical education, and there has been duly constituted "The City and Guilds of London Institute for the Establishment of Evening Classes for Technical Education, or the Application of Science to Industry." Twelve lectures on "Some of the Practical Applications of Electricity and Magnetism," by Mr. W. E. Ayrton, A.M., Inst. C.E., and twelve lectures on "The First Principles of Chemistry," by Prof. H. E. Armstrong, Ph.D., F.R.S., are now in course of delivery. Subsequent courses of lectures on "The Elementary Principles of Mechanics exemplified in our Clocks and Watches," on "The Applications of the Laws of Heat to the Steam and other Engines, and on "Inorganic Chemistry with especial reference to its Technical Applications," have already been arranged.

We trust this example will be followed in our large manufacturing towns, and that when the best system of imparting technical education has been determined, no red-tapeism will hinder it from being speedily and universally adopted. England will then soon regain her former position. Even the Japanese have, as Mr. Ayrton remarks, set us an example that our ambition should lead us to emulate. There has grown up, in the very midst of a people who a few years ago were almost in a state of slavery, a technical college, with its staff of carefully chosen English professors, with its laboratories, class-rooms, museums, libraries, and workshops, costing for maintenance an annual sum of £12,000. To study at this college neither money nor position is necessary; ability and a desire for knowledge are the only qualifications.

IV. ACCIDENTS RESULTING FROM THE HEAT OF THE COMSTOCK MINES.

IN the "Journal of Science" for March last we gave an abstract of a paper on "The Heat of the Comstock Mines," by Prof. John A. Church. The heat in the lower levels of these mines appears to surpass in intensity that of any other mines in the world. Prof. Church's explanation of the phenomena supposes the existence of a cold, and what may be called a burnt out, layer of rocks, extending 1000 feet below the surface; a zone of hot rock still in active decomposition, which has been found to exist for a depth of about 1500 feet or more, and doubtless extends thousands of feet farther; and, finally, a mass of cold rock at a great depth, which has not yet begun to decompose. He refers the high temperature not to the internal heat of the earth, nor to the residual heat of the rocks, which were once melted, but to chemical action now maintained in the erupted rocks. This action is not a combustion, but the chemical alteration of the felspathic minerals of the propylite and other rocks, the peculiar bands of hot and cold rocks which Prof. Church describes, being layers of rock in which decomposition has been delayed and hastened.

Prof. G. F. Barker, who has also visited the mines, concludes,* on the other hand, that the heat is a hot-water heat, and that the waters are heated mechanically by those continuous movements of the country so plainly shown both in the mines and at the surface. But Prof. Church replies that although the Comstock discharges four and a half million tons of water yearly, not 1000 feet out of the 12 miles of linear excavation made every year are in ordinarily wet ground.

The object of this present article is not, however, to discuss the cause of the heat of the Comstock Mines, but to draw attention to the large percentage of accidents resulting from this intense heat. At a recent meeting of the American Institute of Mining Engineers, Prof. Church reviewed, at considerable length, these accidents and their relation to deep mining. From the report in the "Scientific American" we learn that during the twenty-two months preceding May, 1879, there were 101 accidents, killing 53 persons and wounding 70 others. These accidents are classified as follows:—(1) Falls of rock, timber, &c.; (2) Tramming; (3) Effects of heat; (4) Falls of men; (5) Explosions; (6) Hoisting apparatus; (7) Overwinding; (8) Miscellaneous.

In several instances miners have been fatally scalded by falling into the hot mine waters, which exhibit temperatures rising to 158° F. The most remarkable casualties, however, are due to the killing effect of labour in the hot and steaming atmosphere. The proportion of fatal casualties is larger in this class than in any other, being 73 per cent; and from the peculiar mental effects of the heat it is highly probable that it may be the real cause of many mishaps, which under other circumstances would be ascribed to culpable blundering.

On the 1900 level of the Gould and Curry mine a drift was run along and quite near to the black dike, one of the hot spots of the mine. At a spot where the thermometer marked at times 128° F., Thomas Brown fainted while at work. When taken to the surface and revived he was found to have completely lost his memory. He could not tell his name or where he lived, and had to be dressed and taken home by his friends. The newspaper which recorded the occurrence said that such sudden loss of memory from overheating was quite common in the mines, and suggested that the fact might furnish an explanation of the walking off into fatal winzes and chutes by experienced miners, seemingly with deliberate intention.

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* See Letter by G. F. Lesley in Nature, vol. xx., p. 168.

A frequent accident in these mines is fainting in the shaft while the cage is rising to the surface. The faintness is always felt immediately upon reaching the cooler air, 100 or 150 feet from the surface, where there is usually a side draught through some adit. This happens so often that a man who has been working in a hot drift is never allowed to go up alone. Long habitude to the heat is no safeguard against this danger, and serious accidents have occurred in this way.

Among minor casualties, Mr. Church mentions one which happened to Mr. Sutro, in the Sutro Tunnel, before it made a connection with the Savage mine. After spending some time in an air temperature of 110° F., Mr. Sutro went to the air-pipe to cool off. He stayed so long that the miners told him to get away from the pipe and let them have air. He did not move, and when they tried to stir him up with the handles of their shovels they found him unable to move. He had lost all volition, and had to be taken out on a car.

The graver results of overheating include insanity and death. The death of a carman on the 1400 level of the Caledonia mine, Gold Hill, March 11, 1878, is a case in point. He had been idle for six months, and that morning he was working his first shift. At an early hour he rushed into the station of the 1400 level, and reported that the wheels of his car were smashed. The station-master returned with him to his car, and found it all right. There was evidently something wrong with the man, and he was taken to a cooling place. Here decided mental aberration was discovered, and the man, firmly lashed to the cage, was hoisted to the surface, where he fainted at once and died in a few minutes. In this case the heat was only about 90° F.

In another case a miner died from cramps, attributed to heat, but which may have been due to drinking ice-water; and another death is charged to a cold taken while cooling off after being partially overcome with heat. Though contrary to the rules of outside hygiene, the miners resort to copious draughts of ice-water or to exposure to strong cold air currents for recovery from overheating, and usually with impunity. The cold air cooling is considered the safer method; but to gain time Mr. Church commonly chose the ice-water, and never felt any ill effects from it. With several thousand cases a day of rapid cooling off by one or the other of these methods, it is surprising that fatal consequences have been so infrequent.

The next case illustrates the violent effects which excessive heat may have upon a person not accustomed to it:—"On Friday, October 11th, 1878, John McCauley went to work for the first time in the Imperial Mine. He was cautioned against over-exerting himself in the extreme heat of the lower levels. He replied that he thought he was strong enough to stand anything, and paid no attention to the advice. At half-past two in the afternoon he was brought to the surface in an unconscious state, and died the next morning at half-past ten o'clock."

Two other cases very similar to this have occurred in the Imperial within a few years. This mine is excavated in one of the hot spots of the Comstock.

The hot drift on the 1900 level of the Gould and Curry is the scene of the most serious of these casualties due to heat. Five men were sent there in June, 1878, to load a donkey-pump on a car. The work was so exhausting that when the pump caught on a plank they were not able to move it. They seem to have been in a state of mental confusion, but felt that they could not remain longer. Starting up a winze which connects with the 1700 level one man fell on the way, and the others were afraid to stop to help him, but pressed on, reaching the 1700 level in half an hour from the time they left it. They were very confused and nearly speechless, and hardly realised what had occurred. Three men went down to the rescue, and found the fallen man still alive. Clearing the pump they got into the car and signalled to hoist, but on the way up the winze the man they had gone to rescue reeled and fell off. The car was stopped at once, but he was jammed between it and the brattice so fast that the others left him and went for help. They all gave out, two half-way up, and the other just as he reached the 1700 level, where a friendly hand pulled him up. A new rescue party went down and found two men dead, and the third died soon after. The shift boss reports that "the accident was due solely to the heat, as the air is good enough and pure enough, barring the heat." The winze was not an abandoned one, but in daily use. A heavy volume of steam is reported to rise through it from the 1900 level, the temperature of which, at the time of this accident, is given at 128° F. Mr. Church gathers from the detailed account that the death of the men is possibly attributable to the fact that when the miner fell off the car the latter was stopped in a place that was hotter than the rest of the winze.

It is to be regretted that no adequate studies have been made upon the precise physiological phenomena presented by death under these circumstances. The legal requirements are satisfied when it is proved that the casualties are due to heat.

V. ARE THE CHEMICAL ELEMENTS SIMPLE BODIES?

THE researches which have been made in the various branches of physical science during the last few years have many of them been of unusual importance. Some—the telephone and microphone, for instance—have already resulted in the invention of instruments of great practical utility, while others have opened up new fields for research, and bid fair to effect a complete reversal of the generally-accepted notions concerning Matter. As Prof. W. B. Rogers remarked, in his Presidential Address at the 1879 Meeting of the New York Academy of Sciences—"In all branches of discovery we seem to be catching the clews of far-reaching thought that stretch out where as yet no man's foot has trodden. The recent developments in Chemistry, through the agency of the spectroscope, and the effects of heat in dissociation, have suggested, if they have not proved, that a number of the substances hitherto regarded as elements are hereafter to be regarded as compound. The investigation of the laws of chemical action following out the suggestions made at the beginning of the century by the great chemist Berthollet, in regard to the influence of man on chemical reaction, seems to promise most important discoveries in chemical statics and the possibility of applying mathematical reasoning and formulæ to chemical activities. The marvellous series of experiments presented recently by Crookes, in which have been exhibited the wholly unexpected phenomena which he has described under the designation of what was first referred to by Faraday as a fourth form of matter, which this illustrious experimentalist called radiant matter, seemed to open up a field of research and speculation until now wholly undreamed of. In truth, the active scientific workers have now been brought by their refined and novel researches to touch the near extremities of innumerable lines of thought and investigation, stretching out into unknown regions, whose exploration is to occupy the activity and reward the labours of a coming generation."

In discussing the question whether or not the study of the spectrum has thrown, or is likely to throw, any light on the ultimate constitution of matter, Dr. Balfour Stewart* recently referred to the fact that Prout first pointed out that the atomic weights of the so-called elements are very nearly all multiples of the half of that of hydrogen, so that the various elements may possibly be looked upon as formed by a grouping together of certain atoms of half the mass of the hydrogen atom. A most remarkable series of experiments was conducted by M. Stas to test this doctrine. He came to the conclusion that the atomic weights of the various elements were not precisely multiples of the half of that of hydrogen, there being greater differences than could possibly be accounted for by errors of experiment. But Dr. Stewart, calling attention to the great difficulty of obtaining substances absolutely free from all impurity, does not admit that Stas's researches settled the point in the negative, and points to the spectrum as a likely means of throwing some light on the question. Now Mr. Lockyer's researches tend to show that at sufficiently high temperatures the so-called chemical elements, or at all events some of them, are compound bodies. These researches were not undertaken with the view of decomposing the elements. Mr. Lockyer was preparing a map of the solar spectrum on a large scale, and the work included a comparison of the Fraünhofer lines with those visible in the spectrum of the vapour of each of the metallic elements in the electric arc. (The complete spectrum of the sun, on the scale of the working map, will be half a furlong long: in mapping the metallic lines and purifying the spectra more than 100,000 observations were made, and about 2000 photographs taken.) The final discussion of the complete photographs of the spectra of the metallic elements compared with the spectrum of the sun led to the results which are exciting so much interest at the present time.

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* Nature. "On some Points in the History of Spectrum Analysis: an Address to the Natural Philosophy Classes at Owens College, Manchester, November, 1879."

There are certain lines in the spectra of each element which appear long and thick; and it has been found that while such a line, for instance, is exceedingly prominent in some one element, other elements appear to possess it, only not nearly so prominently. Mr. Lockyer argued from this, that on the assumption that the elements are truly elementary, the line in the other elements was caused by traces of impurity. He has, however, found that there are coincidences in the lines of metallic spectra of two perfectly distinct kinds. There are coincidences of lines which are not the prominent lines of any one spectrum, and they give no signs of that variability of brightness that might be expected to characterise lines due to impurities: these lines he has called basic lines. In Mr. Lockyer's own words, "The temperature of the sun and the electric arc is high enough to dissociate some of the so-called chemical elements, and give us a glimpse of the spectra of their bases, just as in the case of the various salts of calcium there is a temperature which just allows us to get a glimpse of a line indicating the metal calcium common to them all."

To determine whether these basic lines varied in their behaviour from other lines of spectra taken at random, Mr. Lockyer had recourse to the spectrum of sun-spots. The sun is surrounded by an enormous atmosphere which is supposed to contain the vapours of such metals as iron and magnesium; but whether this be so or not, Mr. Lockyer argued that the atmosphere would certainly be hotter at bottom—nearer the photosphere—than higher up, and that the spectrum of the atmosphere close to the photosphere would differ from that of any higher region, and therefore from the general spectrum of the sun. In observing the spectrum of a sun-spot, or a prominence, the spectrum of an isolated mass of vapours in the hottest region open to inquiry can be determined, and Mr. Lockyer found that this spectrum differed greatly from the general spectrum of the sun. The whole character of the spectrum of iron, for instance, is changed when we pass from the iron lines seen among the Fraünhofer lines to those seen among the spot and storm-lines. As therefore the spectra of spots and prominences are from the hottest region of the sun, Mr. Lockyer employed them for testing these basic lines. The result has led him to conclude that their appearance in two or more spectra is dependent solely upon high temperature. The basic lines are more prominent in the spectra of spots than in the spectrum of the sun; they are, moreover, more prominent at epochs of sun-spot maximum than during times of minimum. The statement, then, that the spectrum of each element consists only of lines special to that element, is found to be insufficient when the highest temperatures and the greatest dispersions are employed.

A clearer conception of what is meant by the so-called elements being split up at a very high temperature will be gathered from the following illustration, given by Dr. Balfour Stewart:—"If we apply a very powerful source of electricity, we obtain certain peculiar lines from the vapour of calcium. Now if we could catch hold of and segregate —put into a box, as it were—all these minute entities that give us this suspicious line at a high temperature, and, further, if we could keep their high temperature up, I think it is probable that we might obtain something which is not calcium, or, at any rate, something simpler than the molecule of calcium as this appears at lower temperatures. But we are not yet able, and perhaps we may never be able, at an ordinary temperature, to present the chemist with some other substance derived from calcium, which is not calcium."

Much, of course, remains to be done before Mr. Lockyer's views will be universally accepted. The indecomposable character of the bodies which we have hitherto considered elementary has for a long time been considered doubtful. Mr. Lockyer, however, is the first to come boldly forward with experimental proof. What the final result of the discovery will be we cannot foretell. A physical problem, as Dr. Stewart says, begins like a rivulet. At its first introduction it is small and seemingly unimportant; constantly, however, as it winds along it receives accessions from various quarters, until at length it becomes a mighty river that is finally merged in the unfathomable ocean. This course is followed by all such problems. Each begins small, grows broader, and will finally bear us on to the unknown if we trust ourselves to its guidance.

VI. DARWINISM AND ARTICULATE SPEECH.

AT the Meeting of the Academy of Sciences, on the 10th November, 1879, M. Larrey referred to a work written by Dr. Frederic Bateman, of Norwich, on the subject of Darwinism. In the course of his remarks M. Larrey said that Dr. Bateman combats Mr. Darwin's assertion that a difference between man and animals is only one of degree, and not of kind. He has transferred the subject of Evolution to the domain of Psychology, being convinced that hitherto naturalists have concentrated their attention too exclusively on the analogies between the body of man and that of animals, or, in other words, on the purely physical, anatomical, and material characteristics, neglecting the study of the intellectual and metaphysical attributes, which constitute an essential difference between man and animals.

Whilst admitting that man, in his purely physical nature, is closely allied to certain animals, Dr. Bateman repudiates entirely the conclusion drawn from that analogy by Mr. Darwin; for supposing the resemblance of man to an animal bone for bone, nerve for nerve, muscle for muscle, to be proved, what are we to conclude from it if it is also demonstrated that man possesses a distinctive attribute the least trace of which is not found in a brute, an attribute which establishes a gulf between the two? The author affirms that such a distinctive attribute exists in articulate speech. He examines first the doctrine of Darwinism, beginning with an exposition of the principles of Evolution as laid down by Haeckel. He then asserts that no proof exists of the transmutation of species since historic times, and cites the cases of bodies embalmed for three thousand years, and of the birds and animals carved on the ancient monuments of Egypt. He thus confirms what Flourens had already said, viz., "*The species do not alter nor pass from one to the other; the species are fixed.*"

Dr. Bateman then introduces the study of speech as an additional argument against the theory of Evolution, and explains his plan of attack on Mr. Darwin by the three following propositions:—

1. Articulate speech is the distinctive attribute of man, whilst the ape and other animals possess no such power.

2. Articulate speech is a universal attribute of man, and all the races have a language or the capacity of acquiring one.
3. The faculty is immaterial.

Dr. Bateman also discusses and criticises the views of the German neologists on Life-matter and Force, ending with some remarks on the mysteries of life itself.

VII. A REMARKABLE WATER AND GAS GEYSER.

AS early as 1833 a salt well, drilled in the valley of the Ohio, threw columns of water and gas at intervals of ten to twelve hours to heights varying from 50 to 100 feet. A number of wells in the oil regions have since then thrown water geysers, but none have attracted so much attention as one situated near Kane.

The columns are composed of mingled water and gas, the latter being readily ignited. After nightfall the spectacle is grand. The antagonistic elements of fire and water are so promiscuously blended that each seems to be fighting for the mastery. At one moment the flame is almost entirely extinguished, only to burst forth at the next instant with increased energy and greater brilliancy. During sunshine the sprays form an artificial rainbow, and in winter the columns become encased in huge transparent ice chimneys.

The cause of the action is thus explained by Mr. C. A. Ashburner, in "Stowell's Petroleum Reporter":—

This well is situated in the valley of Wilson's Run, near the line of the Philadelphia and Erie Railroad, 4 miles south-east from Kane. It was drilled by Messrs. Gruhout and Taylor, in the spring of 1878, to a total depth of 2000 feet. No petroleum was found in paying quantities, and the casing was drawn and the hole abandoned, since which time it has been throwing periodically—every ten to fifteen minutes—a column of water and gas to heights varying from 100 to 150 feet.

During the operation of drilling, fresh "water-veins" were encountered down to a depth of 364 feet, which was the limit of the casing. At a depth of 1415 feet a very heavy "gas vein" was struck. This gas was permitted a free escape during the time the drilling was continued to 2000 feet.

When the well was abandoned, from failure to find oil, and the casing drawn, the fresh water flowed into the well, and the conflict between the water and gas commenced, rendering the well an object of great interest. The water flows into the well on top of the gas, until the pressure of the confined gas becomes greater than the weight of the superincumbent water, when an explosion takes place, and a column of water and gas is thrown to a great height. This occurs at present at regular intervals of thirteen minutes, and the spouting continues for a minute and a half. On July 31st, 1879, Mr. Sheafer (aid, McKean County) measured two columns, which went to heights respectively of 120 and 128 feet. On the evening of August 2nd Mr. Ashburton measured four columns in succession, and the water was thrown to the following heights:—108, 132, 120, and 138 feet.

VIII. THE TRANSIT OF VENUS IN 1874.*

THE following is a complete transcript of Mr. Hennessey's observatory notes:—"This record was obtained by means of the following agency. My friend, Mr. W. H. Cole, M.A., audibly counted seconds, and named the minutes as completed, from a large chronometer, before which he was comfortably seated, say 6 feet from the equatoreal. Baboo Cally Mohun Ghose, with paper and pencil, took up a position by my side; he mentally followed Mr. Cole's counting, and noted down the instant I made a remark, together with the words I uttered. In the absence of remarks, the Baboo noted the number of each complete minute as it was declared, a reckoning which was checked by inspection of the chronometer and otherwise from time to time, so as to render the adoption of a *wrong* minute practically impossible. Thus all that remained for me to do was to look intently through the telescope of the equatoreal and declare exactly what I beheld. We three individuals were all enclosed within the canvas walling of an observatory tent only 8 feet square, the top of the tent being removed. No sound broke the enforced stillness that prevailed; the sky was brilliantly clear, and all cause for anxiety as to clouding over, or the driving of the equatoreal, or on any other account, was completely absent; while the events in question were plainly seen to progress so gradually and deliberately that there was not the smallest occasion for hurry or confusion of any kind, nor did any occur. Unlike a solar eclipse, when every second is of the utmost importance, there was plenty of time for every purpose. Under these circumstances it was practically impossible that any blunder in recording could be committed.

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* "Further Particulars of the Transit of Venus across the Sun, December 9, 1874; observed on the Himalaya Mountains, Mussoorie, at Mary-Villa Station, Lat. 30° 28′ N., Long. 78° 3′ E.; height above sea 6765 feet, with the Royal Society's 5-inch Equatoreal." By J. B. N. HENNESSEY, F.R.S. Abstract of Paper read before the Royal Society, November 20, 1879.

OBSERVATORY NOTES.

1874. December.		Remarks made by Observer at the time.
Chronometer Time. d. h. m. s.	Greenwich Time. d. h. m. s.	*Ingress.*
		Beautifully clear morning. No haze. Eyepiece 125. Two coloured glasses giving a neutral or bluish field. Missed the first external contact.
8 19 18 0	8 14 6 35	Venus's edge on sun boils somewhat; it is, however, distinctly visible.
20 0	8 35	Venus's outer edge, *i.e.*, against sky, distinctly visible, because of a narrow edging, or ring of light, around some 30° of that part of it farthest from the sun.
20 50	9 25	The light ring now extends around the whole of that part of Venus's edge against the sky, and is some 3″ in width; it is brightest where farthest from the sun.
22 33	11 8	The light ring against sky is well seen, and looks undeniably like Venus's atmosphere; width some 4″; definition excellent.
23 0	11 35	The light ring against the sky can be plainly traced *in continuation* around Venus on the sun, where, however, it is made visible chiefly by the *movements* occurring in it of minute bright specks, and also because it boils. The entire ring is full of these minute bright specks, which appear and disappear rapidly, dancing about with little flashes. Definition excellent.
24 28	13 3	Light ring against sky wider.
25 10	13 45	,, ,, quite distinct.
26 26	15 1	,, ,, quite bright.
28 34	17 9	Transit of Venus's dark edge across the sun's limb, *i.e.*, first internal contact.

1874. December.		Remarks made by Observer at the time.
Chronometer Time. d. h. m. s.	Greenwich Time. d. h. m. s.	
		Ingress.
29 10	17 45	Transit, by estimate, of outer edge of Venus's light ring (that was against sky) across the sun's limb. No ligament or pear-drop seen, *though expected and carefully watched for.*
22 0 0	8 16 48 36	Brilliantly clear sky; light breeze from south.
32 0	17 20 36	Spectroscope set up, adjusted, and used. Slit placed across Venus's *centre* gave a black band all along the length of solar spectrum. Slit placed tangential to Venus's disk gave a faint, narrow, glimmer of light, slightly brighter than solar spectrum, instead of black band; no displacement of solar lines in glimmer.
		Egress.
		Eyepiece as before, 125. Of the two coloured glasses used for Ingress, one now changed for a red glass; field now red and less lighted than at Ingress. Definition sharp and excellent. No boiling visible around sun's limb; some boiling round Venus's lower limb, and still less around upper limb. Removed the red glass and substituted a blue one, when the boiling round Venus became quite visible. Removed the temporary substitute and restored red glass, as before, and thus watched the further progress of the transit.
8 23 9 0	8 17 57 36	About one-fourth of Venus's diameter from contact. No ligament visible.
11 38	18 0 14	About one-sixth of Venus's diameter from contact. No ligament visible.
12 40	1 16	About one-eighth of Venus's diameter from contact. No ligament visible.
15 8	3 44	Less than one-twelfth of Venus's diameter from contact. No ligament visible.
16 0	4 36	About one-twentieth of Venus's diameter from contact. No ligament visible.
16 57	5 32·6	Second internal contact.
22 0	10 36	Light ring now visible around Venus's limb against sky.
34 0	22 36	No boiling around Venus's or sun's limb.
37 30	26 6	Venus's limb against sky only faintly seen.
40 0	28 36	Light ring has been invisible for some time; was seen for only a short time after second internal contact.
44 14	32 49·6	Second external contact. No ligament visible thereafter or at any time before.

The following is an excerpt from a letter by the late Rev. H. D. James to Mr. Hennessey, who was stationed 19 miles from him to the north-west :—

"Chakatra, N.W.P., December 9, 1874.

"Through your kindness in sending me a diagram of the planet's progress across the sun's disk I had as satisfactory a view of it as was possible. My son was with me. At 6.56 we noticed the sunlight on the snowy range. Ten minutes and twelve seconds after that we saw the rim of the sun rising above the mountain which intervened between us and the horizon. We keep an eye on Mussoorie and Landour, and thought they had but two minutes' advance of us in seeing the sun. Eighteen minutes and ten seconds after our first glimpse of the sunlight Venus began nibbling at the rim of the sun. Between this and her entire entrance on to the disk was twenty-seven minutes and ten seconds ; that is, we saw her external contact at 7° 14′ 10″, and her internal contact at 7° 41′ 20″. When she was about half-way on, we both noticed a fringe of white light illuminating that rim of the planet which was yet on the dark sky. When she went off we noticed the same fringe of light, but for a much shorter time, and when only about one-eighth of her had passed the sun's disk. The internal contact for departure took place at 11° 30′ 15″, and the external at 11° 57′ 25, as near as it was possible to say, for there was a sort of flickering, which rendered it difficult to fix on the precise moment of contact.

"The spots on the sun were but insignificant, in magnitude about the same as yesterday, though in position very different."

NOTICES OF BOOKS.

A Handbook of Double Stars, with a Catalogue of twelve hundred Double Stars and extensive Lists of Measures. With Additional Notes, bringing the Measures up to 1879. For the use of Amateurs. By EDWARD CROSSLEY, F.R.A.S., JOSEPH GLEDHILL, F.R.A.S., and JAMES M. WILSON, M.A., F.R.A.S. London: Macmillan and Co. 1879.

IT is said that one-fourth of the stars are multiple stars, and yet their study dates only from the time when the telescope was first used in astronomical research. Thousands of observations have since been made, and much has been written on the subject. There is, however, no convenient handbook for the guidance of students of sidereal astronomy. The present work is written in order that future students may know what stars are of especial interest, at what time observations are especially needful, and what stars have been so frequently and satisfactorily measured that for the present day they need no attention.

The book is divided into four parts. The first part is historical, and descriptive of instruments and methods; the second is mathematical; the third contains lists of measures of the most interesting double and multiple stars, with historical notes on those which are of special interest; the fourth part is bibliographical.

Part I., Chapter II., contains an excellent description of the Equatorial; the Clock, its construction and adjustments; the Observing Chair; and of the best form of Observatory. Chapter III. gives an account of the Equatorials which have been used by double-star observers. Chapter IV. is on the Micrometer; and Chapter V. describes the methods of observing, &c.

The first and second chapters of the second part give a detailed account, with a fully worked example, of determining an orbit and an ephemeris by a purely graphical construction founded on Herschel's and Thiele's methods. An example of the application of analysis to a double-star orbit already approximately known by graphical methods is given in Chapter IV. Chapter V. is on the effects of proper motion and parallactic motion; and Chapter VI. is on the mode of combining observations and determining their weight.

Part III. contains a catalogue of double stars selected as of special interest, with a list of all accessible measures.

The work is illustrated, and is written in such a simple style that the most uninitiated student will have little difficulty in mastering the subject, while it will prove a most valuable work of reference to the experienced astronomer.

PROCEEDINGS OF SOCIETIES

Astronomical Society, *Nov.* 19.—Lord Lindsay, President, in the chair.

Prof. Adams read a paper "On the Ellipticity of Mars and its Effect on the Motion of the Satellites." He said that Prof. Asaph Hall's observations showed that the orbits of both satellites are inclined at small angles to the plane of the planet's equator. It became an interesting question to enquire whether this state of things is a permanent one. Mr. Marth had recently investigated the motion of the nodes of the orbits of the satellites on the orbit of the planet, which will be due to the disturbing action of the Sun, and he came to the conclusion that, if there is no force depending on the internal structure of Mars which modifies the Sun's action, the nodes of the orbits will be in opposition to each other a thousand years hence. But Prof. Adams argued that this motion would be materially affected by the disturbing force due to the ellipticity of the planet, which would cause the nodes of the satellites to retrograde on the plane of the planet's equator. The ellipticity of Mars is too small to be observed, but the motion of the nodes will probably afford a means of determining the ellipticity of the planet within very definite limits.

Mr. Stone read a paper "On the Evidence of a Past Connection between four widely separated Southern Stars, viz., ζ Toucani, ϵ Eridani, ζ^1 Reticuli, and ζ^2 Reticuli."

Mr. Christie read a paper by Prof. C. J. Draper "On a Photograph of the Solar Spectrum, showing dark lines coincident with oxygen lines.

Mr. De La Rue gave an account of a visit to the works of Messrs. Repsold, Hamburg, and described a conical pendulum for the driving-clock of an equatorial which was being made for Professor Winnecke, of Strasburg. The principle was similar to that of the balance-wheel and spring of a watch, for the elasticity of the rod of the pendulum was made use of instead of the force of gravity to resist the centrifugal force caused by the motion of the pendulum. Messrs. Repsold told him that when the driving weight of the clock was changed for another fifteen times as great, the variation and the rate of rotation only amounted to 0·04 per cent.

Dr. Schuster read a paper "On the Polarisation of the Corona."

The President said he had obtained an observation of Deimos at Dunecht. Mr. Christie also obtained observations of Deimos at Greenwich, made on the 4th and 18th of October.

Mr. Common stated that he had on five nights obtained observations and measures of both the satellites of Mars with his 37-inch reflector.

Capt. Noble showed two sketches of the planet Jupiter, showing the great elliptical red marking in the southern hemisphere of the planet.

CHEMICAL SOCIETY, *Nov.* 20.—Dr. Gilbert, F.R.S., in the chair.

"A Chemical Study of Vegetable Albinism (Part II., Respiration and Transpiration of Albino Foliage)," by A. H. Church, M.A. The author has proved that white foliage does not possess the power, even in sunshine, of decomposing the carbon dioxide of the air, but adds largely to the normal amount of that gas in the air, thus resembling the petals of flowers and the action of green leaves during darkness. The best results were obtained with the maple (*Acer negundo*), the holly, the ivy, and the *Alocasia macrorhiza*. The author has also studied the comparative loss and gain of albino and green foliage. White holly sprays placed in water gained, in two hours, 0·29 per cent; green holly, under similar conditions, gained 1·55 per cent. When no water was supplied the white holly lost 0·54 per cent; the green, 10·26 per cent. The author promises further work on this interesting subject. He exhibited some dry specimens of albino and ordinary leaves, the albino leaves being thinner and altogether much less substantial in their structure.

GEOLOGICAL SOCIETY.—The first meeting of the present Session was held on November 5th; the President, Mr. H. C. Sorby, F.R.S., presiding.

The papers read included one by Robert Mallet, F.R.S., "On the Probable Temperature of the Primordial Ocean of our Globe." According to the latest hypotheses as to the quantity of water on the globe, its pressure, if evenly distributed, would be equal to a barometric pressure of 204·74 atmospheres. Accordingly water, when first it began to condense on the surface of the globe, would condense at a much higher temperature than the present boiling-point, under ordinary circumstances. The first drops of water formed on the cooling surface of the globe may not impossibly have been at the temperature of molten lead. As the water was precipitated, condensation of the remaining vapour took place at a lower temperature. The primordial atmosphere would be more oblate and less penetrable by solar heat than the present, and the difference of temperature between polar and equatorial regions would be greater; so that, in the later geologic times, ice may have formed in the one, while the other was too hot for animal or vegetable life. Thus, formerly the ocean would be a more powerful disintegrant and solvent of rocks, mineral changes would be more rapid, and meteoric agencies would produce greater effects in a given time.

A discussion ensued, in which the President, Mr. Evans, Prof. Prestwich, Dr. Hicks, Prof. Bonney, and Capt. Galton took part. In replying, Mr. Mallet said he did not suppose any part of the original crust of the globe remained at present visible at the surface. Such geological deductions as were made in his paper were only illustrative, and might be open to question. The epoch at which the phenomena occurred to which his paper referred was long anterior to the existence of either animal or vegetable life upon our globe. What he affirmed as certain was that the method he had indicated, requiring for its data a more extended experimental knowledge of the relations between temperature and pressure in aqueous vapour, and a more exact knowledge of the total volume of water now upon our terraqueous globe, affords the means of determining the temperature of our oceanic water at every period, from that of the primordial ocean to our own day.

A paper "On the Fish-remains found in the Cannel Coal in the Middle Coal-measures of the West Riding of Yorkshire, with the description of some New Species," was contributed by James W. Davis. The remains described by the author were from a bed of Cannel coal about 400 feet from the base of the Middle Coal-measures, and were chiefly obtained from this bed at the Tingley Colliery. The author described the general geological structure of the district. The following are described as new forms:—(1) *Compsacanthus triangularis*, (2) *C. major*, and (3) *Ostracacanthus dilatatus*, the type of a new genus resembling *Byssacanthus*, Agass.

Prof. R. Owen, C.B., F.R.S., read a paper "On the Skull of *Argillornis longipennis*, Owen," in which he described a fragmentary cranium from the London Clay of Sheppey, from which it was procured by W. H. Shrubsole, Esq.

INSTITUTION OF CIVIL ENGINEERS.—At the second meeting of the Session, held on the 13th of November, Mr. W. H. Barlow, F.R.S., Vice-President, in the chair, the paper read was on "Tunnel Outlets from Storage Reservoirs," by Mr. C. J. Wood, M. Inst. C.E. The subject was divided into the consideration of culverts in a direct line through an embankment, and tunnels round the end of the embankment as a distinct work. The author advocated the tunnel clear of the embankment, and valve-towers of masonry and iron, as the best and safest, if more costly, plan. The paper contained some remarks on the works for the supply of water to Bradford, Yorkshire, which was obtained from three districts. A High Level Supply was taken from the hills above Oxenhope; an Intermediate Supply from Manywell Springs, and a Low Level Supply from Skipton district. The high-level reservoirs afforded instances of tunnel outlets. The Stubden Reservoir had been a cause of anxiety, the original culvert of masonry proving leaky. It had been abandoned in favour of a tunnel lined with cast-iron plates backed with concrete, terminating in a cast-iron valve-tower, erected from the design and under the superintendence of Mr. A. R. Binnie, M. Inst. C.E. The embankment was cut down, the original culvert taken out, and the embankment was then made up solid in thin layers, the new tunnel being used to run water off during the reconstruction of the work. No leakage of any description had since been noticed, the valve-tower and tunnel being water-tight. The Leeming Compensation Reservoir for mill-owners had been originally made with a circular culvert having a slip joint and iron shield where it crossed the puddle-trench. This culvert was seriously fractured by the subsidence of the bank, which was mostly on a clay foundation, and it was considered unsafe to fill the reservoir. On the suggestion of Mr. Rawlinson, C.B., M. Inst. C.E., and of Mr. Binnie, on the latter taking charge of the Bradford Corporation Water-Works, the old culvert was abandoned, and a new tunnel was substituted, similar to the one at Stubden. The original culvert was afterwards filled on the inside with concrete, and the reservoir was successfully filled with water, no leakage or disturbance having occurred up to the present time. In the case of the Leeshaw Reservoir, which was in course of construction, on Mr. Rawlinson's inspection it was resolved to abandon the culvert already cracked, and to substitute a tunnel outlet and valve-tower of cast-iron, similar to those at Leeming and Stubden: this had been successfully done, the reservoir filled, and the work had since proved most satisfactory. In two of the above cases the culverts were so damaged as to be a strong argument in favour of tunnel outlets distinct from the embankment.

PHYSICAL SOCIETY.—The first meeting of this Society for the Session 1879-80 was held on Saturday, November 8th, Prof. W. G. Adams in the chair.

The first paper read was "On an Analogy between the Conductivity for Heat and the Induction Balance Effect of Copper-tin Alloys," by W. Chandler Roberts, F.R.S. Mr. Roberts traced a remarkable resemblance between a curve representing the induction balance effect of the copper-tin alloys published by him in June last, and the curve of Calvert and Johnston for the conductivity of heat, and, on the other hand, he showed that the induction curve does not agree with Matthiessen's curve for the electric conductivity of the same alloys. In the course of his paper Mr. Roberts expressed a hope that Prof. Hughes's beautiful instrument will enable us to determine whether the relation between conductivity for heat and electricity is really as exact as it has hitherto been supposed to be.

Capt. Armstrong exhibited a standard Daniell cell formed of a porcelain vessel with a porous partition dividing it into two compartments. In one the zinc plate was immersed in a solution of sulphate of zinc; in the other the copper plate in a solution of sulphate of copper. To use the cell as a standard, it was only necessary to connect the two liquids by a cotton string moistened with water. This arrangement prevented mixing of the liquids, as the string could be withdrawn after use. The resistance was high, but it was a constant standard of electromotive force.

Prof. Guthrie mentioned that Prof. Pirani, of Melbourne, in a letter to him, had signalled the fact that when a dilute acid was being electrolysed, the positive electrode, if made of iron, became incandescent below the surface of the liquid. Prof. Guthrie had found this to be true not only for iron, but for other metals, and that it could hardly be due to oxidation, because it took place not only at the cathode or positive electrode, where oxygen was evolved, but also at the anode, where hydrogen was evolved. The incandescence appeared to him to be due rather to resistance. The author exhibited his experimental results, which he did not doubt had already been obtained by Prof. Pirani himself. The positive electrode when immersed in the electrolyte was seen to get red-hot and to wobble about. As the liquid heated the red glow became fainter. The negative electrode, on the other hand, emitted a bright light, accompanied by a sputtering noise. The light was tinged with the characteristic colour of the flame of the metal of which it was composed; in the case of a copper electrode, for example, it was greenish. These effects were shown by Prof. Guthrie with iron, copper, and platinum electrodes, in dilute sulphuric and dilute nitric acids.

November 22, 1879.—Prof. W. G. Adams in the chair.

Prof. Guthrie exhibited a new Image Retention Photometer, and demonstrated its action to the meeting.

Dr. Shettle, of Reading, read a paper on the "Influence of Heat upon certain forms of Induction Coils, considered more especially in relation to the Inductive Power which the Blood exercises on the Various Structures of the Body. The author found that when a copper and a zinc wire were insulated from each other by parchment-paper and paraffined silk, and wound in close proximity to each other, an (induced) current was indicated on a galvanometer whose terminals were connected to the neighbouring ends of the zinc and copper wires respectively, the other ends being left free. When the latter were connected across the deflection was *nil*. On raising the temperature of the two wires, by causing hot water to flow inside the coil into which they were wound, the deflection was largely increased. These experiments led Dr. Shettle to imagine that there is a similar action in the animal body. The heart is made up of nerves and muscular fibres winding spirally, and some of these wind round each other so as to form a spiral cord, round which the blood capillaries also wind. Dr. Shettle compares these nerve and muscle bundles to the coils of zinc and copper wire in his experiments, and infers that electric currents may be induced in them as in the wires. The flow of the warm magnetic blood would also tend to produce currents in them. Dr. Shettle, further, drew attention to the fact that animals live and move in a magnetic field, and that electricity must be generated in them by their movements, internal and external.

Mr. Emmott exhibited Crossley's Form of Microphone, which consists of four short rods of carbon jointed loosely into four blocks of carbon, so as to form a square. It is used as a transmitter for telephones, and Mr. Crossley regularly transmits the services of a church with it to several hearers. Its speaking, singing, and whistling powers were successfully demonstrated to the meeting.

ROYAL SOCIETY, *Nov.* 20.—Dr. Spottiswoode, President, in the chair.

"Experimental Researches on the Electric Discharge with the Chloride of Silver Battery," by Warren De La Rue, M.A., D.C.L., F.R.S., and Hugo W. Müller, Ph.D., F.R.S., Part III. In the first part of this paper the authors describe a series of experiments to determine the potential necessary to produce a discharge in a tube, exhausted gradually more and more while using a constant number of cells in all the experiments. The tube employed was 33 inches long and 2 inches in diameter, the distance between the ring and straight wire terminals being 29·75 inches; the battery consisted of 11,000 cells. The next part of the paper deals with the potential necessary to produce a discharge between discs 1·5 inch in diameter, at a constant distance and at various pressures; the remainder being chiefly occupied with the study of the phenomena of the electric arc under various conditions of distance, pressure, and potential. The experiments were made in a bell-jar, containing the terminals, which could be gradually exhausted after having been filled with air or other gas. A remarkable phenomenon was observed on making connection between the terminals and the battery by means of the discharging key, namely, that within certain limits of pressure in the bell-jar a sudden expansion of the gas took place, and that as soon as the connection was broken the gas then as suddenly returned nearly, but not quite, to its original volume in consequence of a slight increase of temperature. The effect was exactly like that which would have been produced if an empty bladder had been suspended between the terminals, and suddenly inflated and as suddenly emptied. This is thought to be produced by a projection of the molecules by electrification causing them to press outwards against the walls of the containing vessel, this pressure being distinct from the motion caused by heat. The appearances presented by the arc in air, hydrogen, and carbonic acid are very beautiful, and are copiously illustrated by copies, in mezzotint, of photographs and drawings. The authors conclude that for all gases there is a minimum pressure which offers the least resistance to the passage of an electric discharge. After the minimum has been reached, the resistance to a discharge rapidly increases as the pressure of the medium decreases. That the potential necessary to produce a discharge between parallel flat surfaces at a constant distance and various pressures, or at a constant pressure and various distances, may be represented by hyperbolic curves. The resistance of the discharge between parallel flat surfaces being as the number of molecules intervening between them. That the electric arc and the stratified discharge in vacuum tubes are modifications of the same phenomenon.

"Preliminary Note on Magnetic Circuits in Dynamo- and Magneto-Electric Machines," by Lord Elphinstone and Charles W. Vincent, F.R.S.E., F.C.S., F.I.C. The experiments which form the subject of this note were made in connection with an investigation as to the best form for the construction of a dynamo-electric machine, intended to furnish currents of high intensity in great quantity. The principles deduced applies equally, however, to magneto-electric machines. The authors show that electro-magnets do not lose their magnetism, as commonly supposed, immediately on cessation of the voltaic current, but that if the poles are "closed" by approximation of other magnets or armatures, the magnetism is retained for an indefinite time. A magnet 58lbs. weight could be lifted by its armature, and sparks obtained from the ends of the wires of its helix a week after magnetisation. The authors have constructed a dynamo-electric machine, in which the "closed magnetic circuit" is utilised, which they propose to describe in a future paper.

"Preliminary Report to the Committee on Solar Physics on the evidence in favour of the Existence of certain Short Periods common to Solar and Terrestrial Phenomena," by Balfour Stewart, F.R.S., and William Dodgson. In a previous Report to this Committee the authors exhibited a method of detecting the unknown inequalities of a series of observations, and gave some evidence that the temperature-range and the declination-range at Kew Observatory are both subject to the same short-period inequalities, the particular periods investigated being those around twenty-four days. In the present paper they investigate, after the method described in their first Report, the following ranges:—

I. Diurnal Ranges of Temperature of Air at—α Kew (already given); β Toronto; γ Utrecht.

II. Diurnal Ranges of Magnetic Declination, including Disturbances at—α Kew; β Prague.

III. Sun-spot Inequalities of the period of twenty-four days, as far as this may be obtained from existing records.

The various results of the present communication are summed up as follows:—

1. The temperature-ranges at Kew, Utrecht, and Toronto exhibit certain common periods (around twenty-four days).
2. Of the curves embodying those periods that of Kew is most like the mean, and that of Toronto least so.
3. Similar phases occur at Toronto eight days before they occur at Kew, and occur at Kew one day before they occur at Utrecht.
4. Correcting for these differences of phase, the individual inequalities of Kew, Utrecht, and Toronto are very like the mean of the three, and like each other.
5. Of these the Kew inequalities are most like the mean, and the Toronto least so.
6. The declination-ranges at Kew and Prague exhibit certain common periods which we may regard as the same, or very nearly the same, as the meteorological periods above indicated.
7. Similar magnetic phases occur at Kew about one day before they occur at Prague.
8. Correcting for this difference of phase, the individual inequalities at Kew and Prague are very like the mean of the two, and like each other.
9. There is also a less striking likeness between the various magnetical and the corresponding meteorological inequalities.
10. Provisional sun-spot records appear to show certain solar inequalities very like the magnetic and meteorological inequalites in point of period.

In conclusion, the authors express the hope that steps will be taken to ascertain what information exists in the world available for these researches, and also to bring such information together for the purpose of a further and more complete discussion of the laws now indicated.

"On the Action of Nuclei in producing the Sudden Solidification of Supersaturated Solutions of Glauber's Salt," by Charles Tomlinson, F.R.S. The author states the general conclusions at which he has arrived since resuming the study of this subject two years ago. In his former papers a nucleus is defined as a body that has a stronger adhesion for the salt, or for the liquid of a solution, than subsists between the salt and the liquid. The action of nuclei the author believes to be simply mechanical, and to be expressed by the familiar word adhesion.

"On the Normal Paraffins," Part III., by C. Schorlemmer, F.R.S. Mr. Schorlemmer is inclined to believe that petroleum consists chiefly of an inextricable mixture of isomeric and homologous paraffins, in which, however, the normal hydrocarbons preponderate.

"On the Solubility of Solids in Gases," by J. B. Hannay, F.R.S.E., F.C.S., and James Hogarth. The authors show the phenomenon of a solid with no measurable gaseous pressure, dissolving in a gas, and not being affected by the passage of its menstruum through the critical point to the liquid state, showing it to be a true case of gaseous solution of a solid.

"The Geometric Mean, in Vital and Social Statistics," by Francis Galton, F.R.S. Mr. Galton's purpose is to show that an assumption which lies at the basis of the well-known law of "Frequency of Error" (commonly expressed by the formula $y=e^{-h^2x^2}$), is incorrect in many groups of vital and social phenomena, although that law has been applied to them by statisticians with partial success and corresponding convenience. Next he points out the correct hypothesis upon which a Law of Error suitable to these cases ought to be calculated. Mr. Galton also communicated a memoir by Mr. Donald McAlister, who, at his suggestion, has mathematically investigated the subject.

ROYAL GEOGRAPHICAL SOCIETY, *Nov.* 24.—The Earl of Northbrook, President, in the chair.

"The Arctic Campaign of 1879 in the Barents Sea," by Capt. A. H. Markham, R.N. The year 1879, the author said, would always be regarded as a very remarkable one in the annals of Arctic exploration, for during the last few months two important geographical problems had been successfully solved: The Swedish ship Vega, under the leadership of that persevering and energetic explorer, Nordenskjold, had completed her voyage from the Atlantic to the Pacific, by rounding the northern outskirts of the old world—a voyage which, even if it should not prove important in a commercial sense, would always rank as one of the greatest geographical feats of the present century; secondly, a small sailing schooner had reached the hitherto inaccessible shores of Franz-Josef Land. The vessel which accomplished this feat was the Dutch exploring schooner Willem Barents. Three hundred years ago the Dutch flag was a formidable rival of the English in the van of Arctic discovery, and English discoverers were delighted that Holland had again entered the lists and obtained a great success. The importance of the achievement of the Willem Barents could not be too highly rated, for the achievement tided over the only difficulty which, in the opinion of a great many Arctic authorities, presented itself with respect to the route for exploration. Early in the present year the author accepted an invitation from Sir Henry Gore Booth to accompany him on a sporting trip to Novaya Zemlya, with the understanding that they should afterwards examine the ice in the Barents Sea and other localities, during what he considered to be the navigable season—namely, during the month of September. For the cruise he had hired the little Norwegian cutter Isbjörn, already rendered historical by her exploits under Payer and Count Wilczek. The Isbjörn was a vessel of 48 tons burden, 55 feet long, with a beam of 17 feet. She was built in 1870, and made her first voyage in the following year with Weyprecht and Payer. The crew consisted of a skipper, mate, two harpooners, and five seamen. They met the first ice on the fourth of June at a distance of 40 miles from the part of Novaya Zemlya coast called Goose Land. The Matochkin Shar was then impassable, and they therefore cruised along the west coast of Novaya Zemlya until they were stopped by the ice off Cape Nassau on July 15. They succeeded in passing through the Matochkin Shar on July 31, and found the Kara Sea full of heavy ice. Returning they met the Dutch exploring vessel Willem Barents on August 18. Here Captain Markham bore testimony to the great kindness they received from the officers and crew of that vessel. Everything they had was placed at their disposal. They then again shaped a course northward, along the Novaya Zemlya coast, and this time succeeded in passing Cape Nassau, and in reaching Cape Mauritius—the extreme north-western point of that land—on September 6. Finally they pushed northward on a meridian midway between Novaya Zemlya and Spitzbergen, and on the 12th they met the ice in latitude 78° north, and longitude 47° east. They pushed on and penetrated through loose streams of ice to 78° 24′, about 80 miles from Franz-Josef Land, and six miles further than that attained by the Dutch expedition last year. Captain Markham had the honour of first carrying the British flag to the northward of Novaya Zemlya. His conclusion was, looking at all the voyages in that direction, that a steamer would have no difficulty in reaching the south coast of Franz-Josef Land during the last week in August, or during the first two weeks in September. If a vessel were once able to establish herself in winter quarters on the west coast of Zichy Land the results would certainly be satisfactory. So long as the land continued to trend northward with a western aspect either a ship or a sledge would follow it without great difficulty, even if it went as far as the Pole. What was wanted in Arctic exploration was perseverance. He trusted that next season a vessel would proceed to Franz-Josef Land prepared to winter, and if it had to return it should be sent out again the following year, and from that starting point attack the work of exploration. With regard to the results of the 1879 expedition, although geographical knowledge had not been greatly increased, yet the observations that had been made with regard to physical geography would prove of the utmost value in future explorations. The Franz-Josef Land route, in his opinion, was the one that would lead to the greatest discoveries in future. The specimens of rocks and fossils brought home were sent to Mr. Etheridge for examination, the birds and eggs to Mr. Fielden, while the plants were sent to Dr. Hooker and Mr. Oliver. A discussion followed in which Count Bylandt, Sir Leopold M'Clintock, Sir George Nares, and Admiral Hamilton took part.

PARIS.

ACADEMY OF SCIENCES, *November* 3.—The memoirs presented at this meeting included the following:—

"Result of the Researches made for the purpose of Discovering the Origin of Re-invasions of *Phylloxera*."—M. Faucon.—The author contends for the superiority of immersion to insecticides. The method he indicates is as follows:—On heavy lands, which hold water well, the immersion should be continued for 55 consecutive days; on moderately light soil, for 65 days; and on very light land, for 75 days. If the immersion is intended to destroy the eggs of *Phylloxera* , it must be carried on without the least interruption for 90 days on medium, and for 120 days on light, lands.

"A New Stellar Spectroscope."—M. L. Thollon.—M. Thollon has arrived at the conclusion that, in order not to repeat indefinitely experiments already made, three things are necessary, viz.:—(1.) That the place of observation should be as high as possible, and in a very favourable climate. (2.) That the greatest possible quantity of light should be concentrated on the slit of the spectroscope by means of an object-glass or a mirror with a broad surface. (3.) That a spectroscope should be used in which the loss of light is reduced as much as possible. It is to the solution of the latter problem that M. Thollon has specially directed his attention. He calculates the loss of light in an ordinary spectroscope to at least 57 per cent. The instrument he has invented contains two compound direct-vision prisms of special form, one in the collimator, the other in the telescope tube. The larger of the simple (or component) prisms has an angle of 100°, and contains a mixture of sulphide of carbon and ether. Two rectangular prisms of crown glass, one on either side, have faces parallel to each other and to the bisecting line of the angle of 100°. With this spectroscope M. Thollon has succeeded in economising light, and, to a certain degree, in making up for the loss that cannot be avoided.

NOTES

BIOLOGY.

THE effects of the bite of the skunk are exciting some discussion. In a Monograph of the North-American Mustelidæ, by Dr. Elliot Coues (see "Quarterly Journal of Science," viii., p. 138), we read that a wound from the teeth of this animal, when in its normal state of health, rarely fails to bring on hydrophobia. The "Forest and Stream" and the "Medical and Surgical Reporter" have more recently taken up the subject. Among the authorities they quote is Dr. Cushing, of Trinidad, Colorado, who gives it as his opinion that the natural bite of the skunk, when not suffering from rabies, never fails to bring on hydrophobia. Dr. W. L. South, who has had great experience in Texas and New Mexico, asserts that the bite sooner or later results in death. It is curious, however, that no similar cases have been recorded in Pennsylvania, where the skunk is very common.

The "Journal de Pharmacie et de Chimie" for October, 1879, contains a paper on the "Actions of Life without Air; their Influence on the Chemical Phenomena of Respiration," by M. Pasteur. The author is led to believe that in the animal economy there take place phenomena of the same order as in fermentation. Oxygen acts not only by effecting combustions, but gives to the cellules an activity whence they derive the power of action beyond the influence of free oxygen, in the manner of the ferment-cells. Direct combustions are of little importance.

At a Congress of Naturalists and Physicians, on the 23rd of September, Prof. Jäger, of Stuttgart, gave a demonstration on his method of examining odours (neural analysis) and on the odours themselves. The professor also spoke on the influence of the temper. Amidst boisterous merriment he appealed to all mothers present if children, when in a good humour, did not give off a pleasant odour, but a disagreeable one when cross or fretful. The lecturer ended amidst hisses.

MM. J. Macé and W. Nicati, in their researches on colour-blindness (described to the Academy of Sciences on Oct. 27th), have sought to obtain comparative measurements between the quantities of light perceived in the different parts of the spectrum by the colour-blind on the one hand, and by the normal eye on the other. A red glass which scarcely lessens the vision of the normal eye diminishes remarkably that of a red colour-blind eye.

MICROSCOPY.

Dr. Pelletan, in the "Journal de Micrographie," 3me année (No. 3, p. 139), complains of the little scientific value of the majority of microscopic objects prepared for sale. Preparations of diatoms are the most satisfactory as they are the easiest to make, and J. D. Möller's "Typenplatte" is especially commended by Dr. Pelletan; certain vegetable preparations, sections of dense substances, animal, vegetable, and mineral, are noticed as being very instructive. But the histological preparations, whether of man or other vertebrates, or of the invertebrates, are stated to be precisely those of least value. The usual insect preparations meet with but little favour from the writer; they present, he says, a magnificent appearance, but the integument is all that has been preserved, and the little that remains of the internal organs is represented by a uniform transparent mass, in which the microscopist finds nothing to study. Some of the English preparations mounted without pressure are very successful, particularly those of spiders, some of which show the internal organs very fairly. Complaint is made that the preparers of animal anatomical subjects have not sufficient knowledge to understand what it is necessary to make visible, and what is the characteristic detail to be rendered evident, in order to make the preparation instructive. They imagine it to be sufficient to take a piece of tissue, injected, or otherwise, harden it, make longitudinal and transverse sections, then steep it in some dye, mount it in a beautiful cell, and by these means obtain a slide useful for something. For example, in certain "commercial" histological preparations the writer notices disassociated muscular fibre, a torn nerve filament, a slice of conjunctive tissue, and the nerve terminations on a muscular fibre. What is learned? The muscular fibres have not been stretched, the sarcolemma is not evident, nor the nodes, nor the least detail of the striæ, discs, and transparent spaces; as to the other portions all is confusion, and nothing clearly displayed. The complaint is certainly true, but, it is to be feared, little will be done, as well made animal preparations are costly, and the purchasers few. Pretty objects are those which pay best.

Dr. John Matthews, F.R.M.S., Vice-President of the Quekett Club, has contrived a machine for making sections of such substances as bone, hard wood, ivory, nut, and other materials which are too hard to be cut with the section knife, and not of a nature to require the lapidary's wheel. The carriage holding the saw runs smoothly yet firmly between friction rollers, and derives its reciprocating motion from a crank, which can be turned either by hand, or when a higher speed is required, driven by a treadle and pulley. The saw is provided with adjustments to secure its parallelism and proper tension; the thickness of the section is regulated by a screw of fifty threads to the inch, reading to thousandths by means of a micrometer head; the feed is either automatic by means of a cup, in which a suitable quantity of shot can be placed, acting by gravitation on a lever; or, as Dr. Matthews prefers, is capable of being regulated by hand. Owing to the steady motion of the saw when in proper adjustment sections of suitable tissues can be cut as thin as the thousandth of an inch; the surfaces show no trace of the saw cut, and are almost polished; very little after treatment is needed to remove the few scratches left by the saw, and if required for mounting in balsam it can be done at once, taking the usual precautions to prevent penetration, and the consequent obliteration of structure. The machine has been constructed with his usual care by Mr. J. W. Bailey.

Some interesting experiments on "Brownian Movements" have been communicated to the Royal Microscopical Society, by Wm. M. Ord, M.D. The paper, which does not admit of profitable abbreviation, will be found in vol. ii. of the Society's Transactions, p. 656.

The Royal Institution Christmas Lectures, adapted to a juvenile auditory, will this year be given by Professor Tyndall, the subject being "Water and Air." As full a report as possible will be given in the "Journal of Science."

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